Vol. I

TRANSCRIPT OF RECORD

Supreme Court of the United States

OCTOBER TERM, 1941

No. 680

U. S. INDUSTRIAL CHEMICALS, INC., PETITIONER,

vs.

CARBIDE AND CARBON CHEMICALS CORPORATION

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE FOURTH CIRCUIT.

PETITION FOR CERTIORARI FILED OCTOBER 4, 1941.

CERTIORARI GRANTED NOVEMBER 10, 1941.

United States Circuit Court of Appeals

FOR THE FOURTH CIRCUIT

No. 4774

U. S. INDUSTRIAL CHEMICALS, INC.,
Defendant-Appellant,

v.

CARBIDE AND CARBON CHEMICALS CORPORATION,
Plaintiff-Appellee.

APPEAL FROM THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF MARYLAND

SUPPLEMENT TO DEFENDANT-APPELLANT'S BRIEF

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SUPPLEMENT TO DEFENDANT-APPELLANT'S BRIEF

District Court of the United States

FOR THE DISTRICT OF MARYLAND

CARBIDE AND CARBON CHEMICALS CORPORATION, *Plaintiff*, v. U. S. INDUSTRIAL CHEMICALS, INC., *Defendant*.	CIVIL ACTION No. 249

INTERLOCUTORY DECREE

This cause came on to be heard on the pleadings and proofs offered by all parties, and was argued by counsel, and thereupon, upon consideration thereof, it was ORDERED, ADJUDGED and DECREED in accordance with the opinion herein rendered:

1. That United States Reissue Letters Patent No. 20,370 granted May 18, 1937 to plaintiff, Carbide and Carbon Chemicals Corporation, a corporation of New York, as assignee of Theodore Emile Lefort, for process for the production of ethylene oxide, were issued upon an application filed September 25, 1936 for reissue of United States Letters Patent No. 1,998,878 which had been issued April 23, 1935;

2. That said United States Reissue Letters Patent No. 20,370 are good and valid in law and in equity as to claims 8 and 9 thereof;

3. That said Theodore Emile Lefort was the first original and sole inventor of the subject matter described in said Reissue Letters Patent No. 20,370 and claimed in claims 8 and 9 thereof;

4. That plaintiff, Carbide and Carbon Chemicals Corporation, is and has been since the grant of said reissue letters patent, possessed of the full and entire right, title and interest in and to the same;

5. That defendant, U. S. Industrial Chemicals, Inc., a corporation of Delaware, maintains a regular and established place of business within the District of Maryland and has there infringed upon claims 8 and 9 of the said Reissue Letters Patent No. 20,370 by practicing a process for the production of ethylene oxide, as set forth in Plaintiff's Exhibit 7

6. That plaintiff, Carbide and Carbon Chemicals Corporation, recover from the defendant, U. S. Industrial Chemicals, Inc., the profits, gains and advantages which it, the said defendant, has received or made or which have arisen or accrued to it from the aforesaid infringement, together with the damages which plaintiff has sustained by reason thereof;

7. That this cause be referred to a Master hereafter to be appointed by the Court to ascertain and take and report to the Court an account of said profits, gains and advantages and to assess said damages; and pending the appointment of said Master and pending the determination of the appeal herein, if taken, the defendant shall file with the Court on or before the 20th day of each month a report under oath of an officer having knowledge of the facts reciting in reasonable detail the output of product made by defendant by the process herein held to infringe during the preceding calendar month, and the amount of such product sold by defendant during the said preceding calendar month. The first said report shall be filed on or before November 20, 1940 and shall recite such output and such sales for the calendar months of July, August, September, and October, 1940.

8. That a perpetual injunction issue out of and under the seal of this Court directed to the said defendant, U. S. Industrial Chemicals, Inc., restraining the said defendant, its officers, directors, associates, attorneys, clerks, servants, agents, employees and privies, and each of them, from directly or indirectly using or causing to be used, any process for the production of ethylene oxide

embodying the invention claimed in claims 8 and 9 of said Reissue Letters Patent No. 20,370 and from in any way infringing upon either of said claims of said reissue letters patent.

9. That plaintiff, Carbide and Carbon Chemicals Corporation, recover of defendant, U. S. Industrial Chemicals, Inc., its costs to be taxed.

WILLIAM C. COLEMAN,
United States District Judge.

Dated, Baltimore, Maryland, May 2, 1940.

OPINION OF THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF MARYLAND

APPEARANCES:

Messrs. WATSON, BRISTOL, JOHNSON & LEAVENWORTH (by L. A. WATSON, Esq., C. W. FAIRBANK, Esq., and CLAIR V. JOHNSON, Esq.), of New York, and Messrs. HERSHEY, DONALDSON, WILLIAMS & STANLEY (by RAYMOND S. WILLIAMS, Esq., and KENNETH EKIN, Esq.), of Baltimore, for the plaintiff.

Messrs. PENNIE, DAVIS, MARVIN & EDMONDS (by DEAN S. EDMONDS, Esq., FRANK E. BARROWS, Esq., and FREDERICK L. BISSINGER, Esq.), of New York, and Messrs. VENABLE, BAETJER & HOWARD (by HARRY H. BAETJER, Esq.), of Baltimore, for the defendant.

COLEMAN, *District Judge*:

This is a patent suit involving a process for the production of ethylene oxide, C_2H_4O, by direct chemical combination between ethylene, C_2H_4,—a hydro-carbon

gas,—and oxygen. Ethylene oxide has various uses, notably when hydrolyzed with water, forming ethylene glycol which is one of the most effective anti-freeze preparations for use in automobiles, and which, therefore, has great commercial value. Soluble in water like alcohol, it is more effective and economical because it does not boil off, like alcohol.

The suit is based upon Reissue Patent No. 20,370, dated May 18th, 1937, which the plaintiff, the Carbide & Carbon Chemicals Corporation, acquired by assignment from one Theodore Emile Lefort, of Paris, France, to whom the original United States Patent No. 1,998,878, was issued on April 23rd, 1935, upon application dated March 22, 1932. This original patent was based upon a process developed by Lefort in France, and there patented March 27, 1931.

The original United States patent, No. 1,998,878, embraced seven claims, and the reissued patent here in suit repeats these seven claims in substantially the same form, but also embraces two additional claims, Nos. 8 and 9, which two are the only ones here in suit, and are virtually identical except in two unimportant respects which will be hereinafter referred to. The specifications in the two patents are quite different in their form,—that is, as to the language employed. Whether any departure in the specifications of the reissued patent from those of the original patent is a material variance, will be considered later.

In both claims 8 and 9, the process set forth for the production of ethylene oxide embraces six steps. We quote claim 8 in full, and have inserted numerals indicating the language in the claim which covers these steps: "The process of making ethylene oxide by the direct chemical combination of oxygen with ethylene in the proportions of one atom of oxygen to one molecule of ethylene, which comprises (1) forming a mixture containing ethylene and molecular oxygen and (2) conducting said mixture through a confined reaction zone which is maintained at an elevated temperature; (3) controlling said temperature to maintain said mixture in said zone at a temperature between about 150° and about 400°C.; (4) subjecting said mixture in said zone at said

elevated controlled temperature to intimate contact with an active surface catalyst of a material having the catalytic characteristics of silver which favors the direct oxidation of said ethylene in said mixture by said molecular oxygen to form oxidation products containing ethylene oxide in the presence of water, and which does not favor the existence in said products of substantial amounts of aldehydes; (5) correlating the passage of said mixture through said reaction zone in the presence of said catalyst and the controlled elevated temperature of said mixture and said catalyst to effect said oxidation of said ethylene directly to form substantial amounts of ethylene oxide; and (6) thereafter recovering ethylene oxide-containing product in liquid form."

Shorn of technical phraseology and summarized very briefly, the process may be described as consisting of the passage of a mixture of ethylene gas and air through a tube containing a silver catalyst heated to a control temperature between approximately 150° and 400°. The direct combination of the air with the ethylene produces ethylene oxide. A side reaction also occurs in that there is destructive oxidation of some of the ethylene, producing carbon dioxide and water. It is claimed in the introductory statements of the patent that "This process is charaterized by an entirely unique reaction in which the direct addition of a single oxygen atom to the ethylene molecule occurs without the formation of significant amounts of other oxgenated compounds such as aldehydes." That is to say, the product is claimed to be a notably clean one,—pure ethylene oxide, in readily recoverable form.

The defenses asserted by the defendant, the United States Industrial Chemicals Inc., are both invalidity of the plaintiff's patent and non-infringement. Defendant urges seven grounds in support of its claim of invalidity, as follows: (1) That claims 8 and 9 are vague and functional, and are expressed in terms of result instead of procedure whereby the result is attained; (2) that the specifications of the original Lefort patent were deficient, in that they did not describe the alleged invention in "full, clear, concise and exact terms" as required by Section 4888 of the Revised Statutes (35 U. S. C. A. Sec.

33); (3) that the patent in suit lacks novelty, in that its specifications describe a method known prior to the effective date of the original French application in 1931; (4) that there has been no disclaimer filed by the plaintiff of claims Nos. 2, 4, 5 and 7, wherein there are claimed methods which are not described in the specifications, and also methods, which are stated to be specifically disclaimed in the sworn statement filed by the plaintiff, in furtherance of its application for the reissued patent in suit; (5) that the specifications of the reissued patent in suit describe, and claims 8 and 9 thereof claim an alleged invention different from that described and claimed in the original patent No. 1,998,878; (6) that the original patent No. 1,998,878 was not inoperative for the protection of the alleged invention therein described, and that, therefore, there was no statutory basis for the reissue of the patent; and lastly (7) that there was no inadvertence, accident or mistake in the application for or ground of the original patent No. 1,998,878, and that, therefore, there was no statutory basis for its reissue.

The defendant rests its defense of non-infringement upon two grounds: (1) the usual ground that the process followed by the defendant is materially different from the process described as the invention of the patentee in the original patent No. 1,998,878, and also in claims 8 and 9 of the reissued patent in suit, when properly interpreted in relation to the original patent; and (2) estoppel, which in turn is based upon two grounds: (a) that claims 8 and 9 of the patent in suit can not be given an interpretation sufficiently broad to include defendant's process, because during the prosecution of the application for the original patent No. 1,998,878, in the Patent Office, broad claims were presented but rejected, and the applicant acquiesced in this rejection, cancelled the claims and in connection therewith, stated that he had made an invention of narrower scope involving use of a specific catalyst which was defined in the claims he retained and which the defendant has not used; also that in the application for the reissued patent in suit other broad claims were presented but were rejected; and that the present plaintiff, then owner of this application, acquiesced in the rejection and cancellation of such claims; and (b) that defendant has acquired intervening rights entitling

it to continue to use its process, by reason of the fact that prior to the filing of the application for the reissued patent in suit and also prior to the granting thereof, the defendant had spent large sums of money in research, investigation, development and commercial use of its present process.

While, as above set forth, there are seven separate grounds alleged by the defendant in support of its charge that the reissued patent in suit is invalid, we will start with the third ground, since the conclusion which we reach, as we are now about to explain, with respect to this and the remaining four grounds, especially the fifth and sixth, namely, that they are untenable. renders untenable the first and second grounds also.

With respect to the third ground, namely, that there is lack of novelty in that the specifications describe a method known prior to the effective date of the original French application in 1931, defendant relies primarily, if not indeed exclusively, upon the contention that Lefort is anticipated by two patents to K. P. McElroy: No. 1,253,617 issued January 15, 1918, upon application filed August 2, 1912, and No. 1,308,797 issued July 8, 1919, upon application filed July 26, 1917. Suffice it to say that the overwhelming weight of the credible evidence on this point is to the effect that these patents did not disclose the Lefort process and, in fact, that the processes purported to be disclosed by these patents have never been demonstrated to be operative or of any commercial value. While Professor Taylor, testifying for defendant, stated that in his opinion the McElroy patents did anticipate Lefort; and while the point has been stressed that these patents were not cited to the Patent Office in connection with the Lefort application, we are not convinced by Dr. Taylor's statements. In fact, it is in evidence that in a treatise published by Dr. Taylor in 1926, the statement appears that the reaction claimed by McElroy was impossible,—a contradiction of his testimony in the present case. The McElroy specifications are far broader than the patent in suit; indeed, are devoid of definition of the requisite temperatures, the silver content of the catalyst, etc. These patents, along with others of McElroy, were purchased by the plaintiff company in 1922

for a nominal sum and, as already stated, there is no proof that they have ever been of any practical or commercial value. No witness in the present suit has ever personally tested the sufficiency of the teachings of these patents in direct relation to the patent in suit.

The fourth ground urged by defendant is a failure to disclaim, that is to say, that there was no disclaimer filed by plaintiff of claims 2 and 4, 5 and 7, wherein there are claimed methods which are not described in the specifications, and also methods which are stated to be specifically disclaimed in the sworn statement filed by the plaintiff, in furtherance of its application for the reissued patent in suit.

It is to be noted that this fourth ground relates to claims which are not at issue in the present suit, and which are of a much narrower scope. Suffice it to say that there is no merit in this point, since a patent will not be invalidated for mere failure on the part of the patentee to disclaim prior to some judicial decision upon the subject matter, i.e., upon one or more of the claims, of the patent. After that, the patentee must act with diligence in accordance with the result of the adjudication. Ensten v. Simon, Ascher & Co., 282 U. S. 445, 455; Maytag Co. v. Hurley Co., 307 U. S. 243.

With respect to the fifth ground, namely, that there is a variance between the invention described in the specifications and claims of the original patent and in the specifications and claims 8 and 9 of the reissued patent in suit, the two main points upon which this argument rests are (1) whether the addition of water in the reaction zone is mandatory in either or both of the patents; and (2) whether the specifications in the respective patents are materially at variance as to the type of catalyst to be used.

Our conclusion is that there is no material variance on either of these points. As to water, the contention of the defendant, as set forth in the testimony of its various experts, is to the effect that the addition of water is mandatory under the requirements of the first patent, but not under the reissued patent here in suit. This argument is a highly technical one and is devoid of any

support except such as is to be found in a highly refined interpretation of the antecedent French patents obtained by Lefort, and of certain language employed in the specifications of the United States patents; and also by isolating, erroneously as we think, this language rather than treating it in a practical manner in the light of the language of the respective specifications and claims read and applied as a whole.

Defendant emphasizes the fact that water is not mentioned in the first or introductory paragraph of the reissued patent in its statement of what the process for the production of ethylene oxide consists, whereas, it is referred to in the corresponding paragraph of the original patent; that is to say, the process is there stated to consist mainly of "subjecting ethylene to the simultaneous action of the oxygen, or air and of water, in presence of a catalyzer, and, if need be, of hydrogen." However, with respect to water, the specifications of the original patent are not essentially different from those in the reissued patent.

We find in the original patent that "Water can be admitted in the reaction vessel, either in the liquid state, or as steam. * * * The efficiency of the reaction is increased by diminishing the $C O_2$ which is formed, by introduction, in this reaction, of a suitable quantity of water. * * * From experiments effected by the applicant, it results that, if water is introduced in suitable quantity, the reaction is not only facilitated as above stated, but, in addition, the reaction giving $C O_2$ * * * is checked, owing, as is probable, to the partial pressure of water. * * * The experiments effected by the applicant have shown that, in presence of the catalyzers indicated, water, in the form of steam or not, considerably promotes the reaction insuring the production of ethylene oxide." Then we find in every one of the seven claims of the original patent specific recognition of the existence of water or steam in the reaction zone.

Turning to the reissued patent, the language is not materially different. For example, it is stated in the specifications that the oxidation of ethylene "can be facilitated by suitable dilution of the reaction gases, such as that accomplished by the use of air as the source of

oxygen, and some water or carbon dioxides in addition to that formed can be admitted to the mixture in the reaction zone if desired. Hydrogen may be similarly added. * * * In any case, the ethylene and oxygen are thus reacted simultaneously at the temperatures set forth in the presence of a surface catalyst and of water. * * *." In the added claims in the reissued patent, that is to say, claims 8 and 9, here in suit, the desired reaction is described as taking place "in the presence of water."

On this point it is the weight of the credible evidence as to what actually has been and can be done under the patents that, in the last analysis, should control, and Professor Arthur B. Lamb, testifying on behalf of the plaintiff, has satisfied the Court, through his very clear exposition of the character and results of his laboratory tests, that one skilled in the art, following the teachings of the original patent, will be successful in producing what that patent calls for, and in obtaining such result whether the addition of water be considered as mandatory or as optional, and that he will obtain the same result if he follows the teachings of reissued patent in suit. In other words, what Professor Lamb accomplished by following the original patent proves not only the adequacy of its disclosure as to how to carry out the process successfully, but, in addition, conclusively demonstrates that there is no variance between the subject matter of the original and the reissued patent. It is particularly significant that Professor Lamb never saw the reissued or the third French patent (hereinafter referred to) until after he had testified in the present case. He stated that it never occurred to him that the specifications of the original patent required the addition of water, but that it was advisable to make the addition, in view of the aggregate that was said to facilitate the reaction and, therefore, he did not dry the air. In other words, he decided to use the air either as it came, or with the slight additional amount of moisture that it might pick up from going through the wash bottle.

Summarizing his conclusions, Professor Lamb stated that although he had not read the reissued patent, it necessarily followed from the results of his experiments under the original patent that, even if he had studied the

reissued patent and even if it be assumed that water was specifically omitted as a requirement therefrom, this would not, from the technical chemical point of view, be a material departure.

Defendant has injected into the case a very large amount of testimony with respect to French patents issued to the assignee of Lefort, namely, the Societe Anonyme; Societe Francaise de Catalyse Generalisee, of Paris, as well as certain British patents issued to the same patentee, in an attempt to prove that the process originally conceived by Lefort, in 1931, and patented in France and Great Britain, required the use of water added in more or less large amounts, and that it was not until after the French patentee had applied for a third patent in France in 1933, from which, as it is alleged, the mandatory requirement of his other patents that water be introduced into the reaction chamber was omitted, thereby reducing production costs and explosion hazards, that the plaintiff applied for the reissued patent in suit. In other words, defendant claims that the original United States patent has been reissued as a patent for an invention which had not been made at the time the application for the original was filed; that the reissue is a patent for a different process described in the third French patent and the third British patent, and although based upon a 1931 filing date, is a patent for a 1933 invention.

In support of this contention defendant has gone to great length to analyze the language of the first two French patents, No. 729,952 and No. 739,562, with their various additions, the first of which is stated to be a patent for a process for producing ethylene glycol, and the second for a process for producing ethylene oxide; and also the two corresponding British patents, Nos. 402,438 and 402,749. Reliance is also had upon the assertions of the patentee in the third French patent, No. 771,650, and the third British patent, No. 431,966, to the effect that the invention protected by those patents was, in fact, a new discovery constituting an improvement over the prior patents and embracing certain definite advantages.

But the reissued patent in suit can only be invalidated by evidence far more convincing then what the defend-

ant has produced on this score. Indeed, a critical analysis of the various French patents with their additions, and of the various British patents, is not necessary since they can conclude nothing for our purposes, in view of the testimony already analyzed and which stands, as we think, totally without any successful refutation, given on behalf of the plaintiff by Professor Lamb, and confirmed by Professors Frazer and Stevenson, to the effect that by virtue of their own personal tests made in the light of their knowledge of this branch of chemistry, there is no material difference in the teachings of the original United States patent and the reissued patent in suit with respect to the need for the addition of water in the reaction zone; and that it is only through placing an emphasis, unwarranted by both specifications and claims, upon the reference to water as an ingredient of the process, that any distinction is to be found between the requirements of the respective patents. Indeed, while it is very difficult to reconcile a good deal of the language employed in the various French and British patents,—some of the experts who testified being themselves unable to explain away certain apparent contradictions in the various representations made with respect to the successive claims,—we may assume that under French or British law it may have been appropriate to accord, as was done, the dignity of a patent to the various alleged distinctions and still we are not required to give any conclusive effect to the same in this proceeding.

Finally, whatever weight might otherwise be attached to these foreign patents and the various representations made in connection therewith, is negatived not merely by the contrary findings based upon practical as opposed to merely theoretical considerations, as above explained, but by the fact that the conclusion that the defendant would have us draw from this line of argument, namely, that the application for the reissued patent in suit was inspired by and had no other basis than the third French and British patents, is completely refuted by the unimpeached testimony of plaintiff's patent attorney to the effect that, in his search of the Patent Office records, he found no evidence that applications had ever been made there for patents based upon the third French or British patents, and also, that he had no knowledge of

these patents when he had charge of the application for the reissued patent in its progress through the Patent Office. This supports Professor Lamb's conclusion,—which necessarily follows from the rest of his testimony,—that the third French and British patents represented no actual improvement in the process, by dispensing with the introduction of water vapor into the reaction zone, and thus minimizing, or obviating entirely, explosion hazards by avoiding the necessity of vaporizing large amounts of water.

The Court requested that tests be made in advance of the trial in the presence of representatives of both sides,—confirmed by its insistence upon the appointment of Professor Frazer as a neutral inter-partes expert witness, so that precisely such questions as this one, relating to the use of water might be thoroughly thrashed out in advance of the trial. Yet, after eight days of trial, the defendant produced no witness that had made, or had cooperated with Professor Frazer in making, any inter-partes tests following the teachings of either the original or the reissued patent. So it seems to the Court that the testimony, clear and convincing, of Professors Lamb and Stevenson, and the testimony to the same effect by Dr. Curme, Director of Research for the plaintiff company, supported fully as it is by the inter-partes tests made by the neutral expert, Professor Frazer, must control.

So much for the question of the requirement as to water in the respective patents. Turning to the second question, namely, whether there is nevertheless, a variance in the two patents with respect to the catalytic specifications, we have no hesitancy in concluding, from the weight of the credible evidence, that this question likewise must be answered in the negative.

The gist of defendant's contention is that the specifications and claims are too broad and indefinite with respect to what catalyst shall be used. In other words, the defendant would have us believe that what is specified is merely the use of a silver catalyst that will work, with admonition against using one that will not work,—namely, that the specifications and claims are expressed in terms of the desired result, rather than in terms de-

scriptive of the catalyst itself that will produce such result.

We find this argument totally lacking in merit and, again, the best evidence that this is true is to be found in the testimony of Professor Lamb. Without any knowledge whatsoever of the French patents or of the reissued patent in suit, he followed the teachings of the original patent. He testified that he wanted to avoid trying a number of catalysts and he reasoned that the most efficacious one, and the simplest to prepare, would be one consisting solely of silver because silver was so frequently mentioned in the specifications. He, therefore, used granules of silver oxide, being a compound of silver that would decompose at temperatures within the range specified. He used no carrier, lest he might select one that would be active in decomposing ethylene oxide, and he did not want to assume this handicap. In his first experiment, the conversion of ethylene to ethylene oxide was as high as 28.7%, and in his last experiment (some eleven were made in all), the conversion percentage was as high as 37.7%. His average for all the tests was approximately 33% which, as well as the lowest percentage that he obtained, concededly represents good conversion for commercial purposes. Professor Frazer also used a silver oxide catalyst, but sustained it in filtros. He also used no additional water,—only the water-vapor that entered with the gas mixture, and emphasized his belief that the amount of water was not important. His conversion percentages were somewhat less than Professor Lamb's.

In view of what Professor Lamb was able to do according to the teachings of the original patent, it is idle to contend that the same could not be done by following the teachings of the reissued patent because there is no real variance between the two. In the original patent, twelve different catalysts are set forth, whereas, in the reissued patent there is no such enumeration, the specifications merely prescribing the use of "such a surface catalyst as one composed of silver in finely divided form, and which may be disposed within the tube on a supporting material, or in other known ways." However, in the original patent in two out of the three modi operandi

given as illustrations, as well as in each of the seven claims of that patent, silver, or a mixture containing silver in some form, is specifically referred to. So, this ties up precisely with the specifications of the reissued patent to the effect that a catalyst should be used "composed of silver in finely divided form, and which may be disposed within the tube on a supporting material, or in other known ways"; also, with the further statement, in the reissued patent specifications that "The surface catalyst is preferably silver as stated, but other metals such as bismuth and antimony may be used," and with the fact that each of the first seven claims of the reissued patent (whose language is virtually identical, except for slight transpositions of phrases, with that of the seven claims of the original patent) call for a catalyst composed of silver, or a mixture containing silver.

Defendant stresses the case of Russell v. Dodge, 93 U. S. 46. We find nothing, after a careful examination of this case, in conflict with our decision, because in that case there was obviously not merely a clarification but a change from one invention to a different one.

In deciding as we do, we are not unmindful of the fact that Professor Frazer queried whether the clause in claim 8 (broader than the corresponding one in claim 9) calling for "material having the catalytic characteristics of silver" might be too broad,—i.e. might include *all* future discoveries in this catalytic field,—conceivably catalysts having no silver content whatsoever. However, we do not entertain any doubt as to the validity of the claim on this score, because it must be read in the light of the specifications which, in turn, in their broadest aspect, are to be interpreted as embracing besides silver, only such other metals as are actually enumerated or were actually known, at the time of the original application.

There is one other difference to be noted between claims 8 and 9, i.e., that the latter does, but the former does not, expressly provide for the use of "a heat-absorbing diluent." But this difference is not of material significance, since the use of such a diluent is provided for, optionally in the specifications of both patents, and in

both the same diluents are specified, namely, oxygen, hydrogen, or carbon dioxide.

Defendant claims that Professor Lamb's testimony should be given no credence because it is opposed to the oral testimony of representatives of the Dutch Shell Company, which had had an option to acquire the United States rights in the French patents and in the pending United States application, but which it declined to exercise, because its laboratory tests produced unsatisfactory results; and to certain correspondence introduced in connection with the testimony of these same witnesses, out of which certain parts are taken and stressed as indicating not merely an admission on the part of the French company, the owner of the pending United States application, that it was deficient in its disclosure, but that there was a wilful withholding of necessary specifications. Also, we are asked to reject Professor Lamb's testimony on the ground that his experiments were ex parte.

We are not impressed with any part of this position taken by the defendant. In the first place, defendant can ill afford to attack the experiments and results obtained by Dr. Lamb, or by the other experts for the plaintiff, as being ex parte, since they are not only fully corroborated by tests made by Professor Frazer, pursuant to Court order, in the presence of defendant's representatives, but since defendant has wholly failed to present to the Court *any* experiments whatsoever, conducted by any of its own witnesses pursuant to the requirements imposed in connection with the appointment of Dr. Frazer.

As for the testimony in connection with the Dutch Shell Company's efforts, suffice it to say that we find nothing improper in the correspondence of the French Company above referred to, when considered as a whole, in the light of the business transactions that were involved. Indeed, this correspondence, when so considered, confirms the bona fides of plaintiff's contention that there was real need for clarification of the original United States patent, and that this was the sole basis for the application for the reissued patent and additional claims, and for the changes in the specifications in that applica-

tion over the original application, and for the variations in the additional claims over the claims of the original patent.

Finally, the testimony of the Dutch Shell representatives loses weight because of the admission of one of that company's officials that he was not a disinterested witness in the present litigation, in that, if the patent in suit should be held invalid, his company contemplated entering into the manufacture of ethylene oxide.

Turning to the sixth ground, which is that the original patent was not inoperative for the protection of the alleged invention and that, therefore, there was no statutory basis for the reissue of the patent, this ground is so intimately related to the seventh ground that the two might well be considered as one.

We do not understand that it is necessary, in order to warrant a reissue of a patent, that the original patent be inoperative in the literal sense. The power to reissue a patent may be exercised when the original patent is inoperative in the sense that its specifications are defective or insufficient, or when the claims are narrower than the actual invention of the patentee, provided the error has arisen through inadvertence or mistake, and the patentee is guilty of no fraud or deception; and provided, of course, that the reissue shall be for the same invention as the original patent, as disclosed by the specifications and claims of the original, and that due diligence is exercised in discovering the mistake in the original patent. 35 U. S. C. A. Sec. 64. A delay of two years is too long, in the the absence of very special circumstances. Wollensak v. Reiher, 115 U. S. 96; Topliff v. Topliff, 145 U. S. 156; Webster Co. v. Splitdorf Co., 264 U. S. 463, 466. We find that the plaintiff has met these requirements. It is to be noted that the application for reissue was filed within a year and a half after the original patent was issued.

On the seventh ground, namely, that there was no inadvertence, accident or mistake in the application for or grant of the original patent and that, therefore, there was no statutory basis for its reissue, we conclude that the affidavit by the French attorney,—who was not him-

self a chemist and who sets forth why, acting merely as attorney in Paris and transmitting the papers to the attorney in Washington, he unduly restricted the original application,—adequately disposes of this seventh ground, and we do not consider it is necessary to discuss further the contents of this affidavit. Topliff v. Topliff, supra. The bona fides of the application is further confirmed by the testimony of the attorney for the plaintiff company to the effect that in 1936, after the company's chemists had accomplished satisfactory results in their experiments with the Lefort process, and the company had begun to negotiate for the purchase of the original patent, he examined further into its claims in the light of the original French patents, but without any knowledge of the third French patent, and concluded that the original United States patent was basic; that its claims were too narrow and that, thereupon, he began the preparation of the application for the reissue.

Coming now to the question of infringement, and taking up the first ground of defendant's defense of non-infringement, namely, that the process followed by it is materially different from the process described as the invention of the patentee in the original patent, and also in claims 8 and 9 of the reissued patent when properly interpreted in relation to the original patent, we find no merit in this contention. Plaintiff has graphically set forth in printed exhibits (Plaintiff's Exhibits Nos. 8 and 9) in parallel lines what is required, step by step, under the two claims in issue of the reissued patent, and what is actually admitted as done under defendant's process. Because of the unquestioned similarity, step by step, of the two processes, and because of the almost complete identity of claims 8 and 9, it seems sufficient if we incorporate in this opinion by reference, without copying, the aforementioned comparative analyses of these claims and defendant's process. Again, the Court is unfortunately without the benefit of the results that would have been disclosed had tests been made, as it was understood they would be, on behalf of the defendant, in the presence of plaintiff's representatives, of the process in accordance with the reissued patent and with the process commercially followed by the defendant in its own plant. However, were the results of such tests available, it is

obvious that they would not fail to be corroborative of the conclusion here reached that the processes are virtually identical, and that, therefore, defendant is guilty of infringement. Indeed, in the course of the trial defendant's counsel has admitted that if the presence of water in the reaction zone is found to be optional in either claim 8 or 9, then defendant infringes.

We come then, finally, to the second ground of the defense of non-infringement which, as we have seen, is twofold: (a) that claims 8 and 9 of the reissued patent can not be given an interpretation sufficiently broad to include defendant's process because, during the prosecution of the application for the original patent, broad claims were presented but rejected and the applicant acquiesced in this rejection, cancelled the claims and in connection therewith, stated that he had made an invention of narrower scope, involving the use of a specific catalyst which was defined in the claims he retained; also that in the application for the reissued patent, other broad claims were presented but were rejected; and that the plaintiff, then owner of this application, acquiesced in the rejection and cancellation of such claims; and (b) that defendant has acquired intervening rights entitling it to continue to use its process, by reason of the fact that, prior to the filing of the application for the reissued patent in suit and to the granting thereof, the defendant had, by research, investigation and development, devised and used its present process, involving large expense.

Taking these grounds up in the order stated, the first one may be dismissed forthwith, because it is the same as the fourth contention raised by defendant in its attack upon the validity of the reissued patent, which we have already fully discussed and found to be without merit.

As to the second ground, namely, that of intervening rights, it is difficult to understand how this contention can be seriously made. The principle invoked is well established, namely, that a patentee having consciously accepted with satisfaction a patent of given scope, may not remain idly by and allow his competitor to build up a business outside the scope of the patentee's claims and

thereafter, with a desire to capitalize and take from his competitor what the latter has innocently created or developed, secure a reissuance of the patent so as to embrace the domain of his competitor. See Sontag Stores Co. v. Nut Co., 310 U. S. 281. But it appears that defendant never began to construct its present costly plant until after the reissued patent had been granted; and never began to operate it commercially for the production of ethylene oxide until more than two years later. It is a correct inference from the testimony that prior to the application for the reissued patent, defendant's work on this process amounted to relatively little, but that thereafter, defendant zealously progressed its development of plant and process, with a view to capitalizing what plaintiff had done. It has been testified on behalf of the defendant that more than $1,000,000.00 has been invested in its plant in Baltimore. But this was done by the company's officials with their eyes open to possible results. If they were too hasty or ill-advised with respect to possible conflict between their rights or interests and those of the plaintiff, this is not something that a court of equity can relieve against. Indeed, it is precisely the sort of thing which a court of equity should condemn, not condone.

Defendant's counsel has attempted to make something of the point that the original Lefort patent was not used for five years, and that it is, therefore, to be treated as, in effect, a paper patent. But it issued in 1935, there was competitive bidding for it until plaintiff acquired it in 1936, and the transition of the invention from laboratory demonstration to commercial installation was very rapid. Before the close of the following year plaintiff had erected and was operating a large plant at South Charleston, West Virginia, which now has a yearly output of more than ten million pounds. The French company had licensed the process in England, Belgium, Italy and Russia, and it had also been sought by German interests. In short, the value of the patented process had been recognized commercially in the important European industrial countries.

Defendant stressed the fact that up to the time the application for the reissued patent was filed, namely,

September 25, 1936, its research work had been steadily progressing for some two years, at a cost of over $100,000.00, and that this work was continued during the period that the application was pending, resulting in additional cost to the defendant of more than $50,000.00; also, that during this period, defendant had acquired its United States patent No. 2,125,333 for a catalyst, and had proceeded to develop a plant in which this invention was to be practiced. Defendant relies upon Sontag Stores Co. v. Nut Co., supra, and Otis Elevator Co. v. Atlantic Elevator Co., 47 F. (2d) 545, a decision of the Circuit Court of Appeals, 2nd Cir. Defendant insists that its operations should be considered as entitled to protection up to the date of the application for the reissue, even if not to the date of its granting, and even though all such operations were entirely in the experimental and development stage, as distinguished from commercial operations. The cases relied upon do not so decide, nor do any to which we have been referred. In the Sontag case, the facts are quite different from those here presented. There, the Court assumed, without deciding, the correctness of the lower Court's conclusion that the enlarged reissue claims were valid and infringed. Also, the reissue was applied for within two years after the granting of the original patent. But here the analogy to the facts in the present case ceases, because in the Sontag case, the infringer actually began to use the accused machine within a year after the original patent was granted, and his manufacturer had begun to make and sell like machines two or three months thereafter; whereas in the present case, as already pointed out, the defendant not only did not enter upon the commercial production of ethylene oxide until more than two years after plaintiff had obtained its reissued patent, but never started the construction of its plant until after the reissue had been granted. With respect to the Otis Elevator case, the reissue there was not applied for until more than seven and one-half years after the original patent had been obtained, three of which were excused on account of the intervention of war, but the additional delay was not. The intermediate advance in the particular art there involved, i. e., that relating to stopping devices for electric elevators, was also an important

factor. So, this case, likewise, is entirely different upon its facts from the case at bar.

For the aforegoing reasons a decree will be signed holding claims 8 and 9 of the patent in suit both valid and infringed.

WILLIAM C. COLEMAN.

FINDINGS OF FACT AND CONCLUSIONS OF LAW

Findings of Fact

1. The patent in suit involves a process for the production of ethylene oxide C_2H_4O, by direct chemical combination between ethylene, C_2H_4,—a hydro-carbon gas,— and oxygen. Ethylene oxide has various uses, notably when hydrolyzed with water, forming ethylene glycol, which is one of the most effective anti-freeze preparations for use in automobiles, and which, therefore, has great commercial value. Soluble in water like alcohol, it is more effective and economical because it does not boil off, like alcohol.

2. The suit is based upon Reissue Patent No. 20,370, dated May 18th, 1937, which the plaintiff, the Carbide & Carbon Chemicals Corporation, acquired by assignment from one Theodore Emile Lefort, of Paris, France, to whom the original United States patent No. 1,998,878, was issued on April 23rd, 1935, upon application dated March 22nd, 1932. This original patent was based upon a process developed by Lefort in France, and there patented March 27th, 1931.

The original United States patent, No. 1,998,878, embraced seven claims, and the reissued patent here in suit repeats these seven claims in substantially the same form, but also embraces two additional claims, Nos. 8 and 9, which two are the only ones here in suit, and are virtually identical except in two unimportant respects which will be hereinafter referred to. In both claims 8

and 9, the process set forth for the production of ethylene oxide by the direct chemical combination of oxygen with ethylene in the proportions of one atom of oxygen to one molecule of ethylene, embraces six steps: (1) forming a mixture containing ethylene and molecular oxygen and (2) conducting said mixture through a confined reaction zone which is maintained at an elevated temperature; (3) controlling said temperature to maintain said mixture in said zone at a temperature between about 150° and about 400° C.; (4) subjecting said mixture in said zone at said elevated controlled temperature to intimate contact with an active surface catalyst of a material having the catalytic characteristics of silver which favors the direct oxidation of said ethylene in said mixture by said molecular oxygen to form oxidation products containing ethylene oxide in the presence of water, and which does not favor the existence in said products of substantial amounts of aldehydes; (5) correlating the passage of said mixture through said reaction zone in the presence of said catalyst and the controlled elevated temperature of said mixture and said catalyst to effect said oxidation of said ethylene directly to form substantial amounts of ethylene oxide; and (6) thereafter recovering ethylene oxide-containing product in liquid form.

The process may be briefly described as consisting of the passage of a mixture of ethylene gas and air through a tube containing a silver catalyst heated to a control temperature between approximately 150° and 400°. The direct combination of the air with the ethylene produces ethylene oxide. A side reaction also occurs in that there is destructive oxidation of some of the ethylene, producing carbon dioxide and water.

3. The reissued patent in suit is valid.

4. Claims 8 and 9 of the plaintiff's patent are not so vague and functional as to render said patent invalid, but describe the procedure and not merely the result attained thereby.

5. The specifications of the original Lefort patent were sufficient in that they described the alleged invention in "full, clear, concise and exact terms" as required by Section 4888 of the revised Statutes (35 U. S. C. A. Sec. 33).

6. There is no lack of novelty in the patent in suit, for the specifications describe a method unknown prior to the effective date of the original French application in 1931. The two patents to K. P. McElroy (No. 1,253,617 issued January 15, 1918, upon application filed August 2, 1912, and No. 1,308,797 issued July 8, 1919, upon application filed July 26, 1917) did not disclose the Lefort process and, in fact, the processes purported to be disclosed by these patents have never been demonstrated to be operative or of any commercial value. The McElroy specifications are far broader than the patent in suit; indeed, are devoid of definition of the requisite temperatures, the silver content of the catalyst, etc. These patents, along with others of McElroy, were purchased by the plaintiff company in 1922 for a nominal sum.

7. There is no variance between the invention described in the specifications and claims of the original patent and in the specifications and claims 8 and 9 of the reissued patent in suit.

8. With respect to water, the specifications of the original patent are not essentially different from those in the reissued patent. Professor Arthur B. Lamb, testifying on behalf of the plaintiff, has satisfied the Court, through his very clear exposition of the character and results of his laboratory tests, that one skilled in the art, following the teachings of the original patent, will be successful in producing what that patent calls for, and in obtaining such result whether the addition of water be considered as mandatory or as optional, and that he will obtain the same result if he follows the teachings of the reissued patent in suit. In other words, what Professor Lamb accomplished by following the original patent proves not only the adequacy of its disclosure as to how to carry out the process successfully, but, in addition, conclusively demonstrates that there is no variance between the subject matter of the original and the reissued patent. This testimony is confirmed by the testimony of Professor Frazer, the inter-partes neutral witness, and also by that of Professor Stevenson and Dr. Curme, witnesses for the plaintiff.

9. The application for the reissued patent in suit was not inspired by and was not based on the third French

and British patents. Plaintiff's patent attorney, in his search of the Patent Office records, found no evidence that applications had ever been made there for patents based upon the third French or British patent. It is also clear that he had no knowledge of these patents when he had charge of the application for the reissued patent in its progress through the Patent Office.

10. There is no variance in the two patents with respect to the catalytic specifications. In the original patent, twelve different catalysts are set forth, whereas, in the reissued patent there is no such enumeration, the specifications merely prescribing the use of "such a surface catalyst as one composed of silver in finely divided form, and which may be disposed within the tube on a supporting material, or in other known ways." However, in the original patent in two out of the three modi operandi given as illustrations, as well as in each of the seven claims of that patent, silver, or a mixture containing silver in some form, is specifically referred to. So, this ties up precisely with the specifications of the reissued patent to the effect that a catalyst should be used "composed of silver in finely divided form, and which may be disposed within the tube on a supporting material, or in other known ways"; also, with the further statement in the reissued patent specifications that "The surface catalyst is preferably silver as stated, but other metals such as bismuth and antimony may be used," and with the fact that each of the first seven claims of the reissued patent (whose language is virtually identical, except for slight transpositions of phrases, with that of the seven claims of the original patent) call for a catalyst composed of silver, or a mixture containing silver.

11. The clause in claim 8 (broader than the corresponding one in claim 9) calling for "material having the catalytic characteristics of silver" must be read in the light of the specifications which in turn in their broadest aspect are to be interpreted as embracing besides silver only such other metals as are actually enumerated or were actually known at the time of the original application.

12. Although claim 9 does and claim 8 does not, expressly provide for the use of a "heat-absorbing diluent,"

this difference is not of material significance, since the use of such a diluent is provided for optionally in the specifications of both patents, and in both the same diluents are specified, namely oxygen, hydrogen, or carbon dioxide.

13. The correspondence of the French company, then owner of the French patents and the pending United States application, with the Dutch Shell Company, which had an option to acquire the United States rights in the French patents and in the pending United States application, discloses that there was real need for clarification of the original United States patent. This need afforded a basis for the application for the reissued patent and additional claims, and for the changes in the specifications in that application over the original application, and for the variations in the additional claims over the claims of the original patent.

14. The original patent was sufficiently inoperative for the protection of the alleged invention to warrant the reissue of the patent. While it may not have been inoperative in the literal sense, the original patent was inoperative in the sense that its specifications were defective or insufficient and the claims were narrower than the actual invention of the patentee. Such error arose through inadvertence or mistake, the patentee being guilty of no fraud or deception. The error was discovered with due diligence, and the application for the reissue was filed within a year and a half after the original patent was issued.

15. Defendant infringes plaintiff's reissued patent in suit.

16. The process followed by defendant is not materially different from the process described as the invention of the patentee in the original patent and in claims 8 and 9 of the reissued patent, as becomes obvious from an examination of Plaintiff's Exhibits Nos. 8 and 9 setting forth comparative analyses of the two processes step by step, which analyses are incorporated by reference in these findings of fact.

17. Defendant acquired no such intervening rights as would estop plaintiff from asserting defendant's in-

fringement. Defendant never began to construct its present costly plant until after the reissued patent had been granted; and never began to operate it commercially for the production of ethylene oxide until more than two years later. Prior to the application for the reissued patent, defendant's work on this process amounted to relatively little, but thereafter, defendant zealously progressed its development of plant and process, with a view to capitalizing what plaintiff had done. Defendant's investment of more than $1,000,000 in its plant in Baltimore was made by the company's officials with their eyes open to possible conflict between their rights or interests and those of the plaintiff.

18. The original Lefort patent is not to be treated as, in effect, merely a paper patent. It issued in 1935, there was competitive bidding for it until plaintiff acquired it in 1936, and the transition of the invention from laboratory demonstration to commerical installation was very rapid. Before the close of the following year plaintiff had erected and was operating a large plant at South Charleston, West Virginia, which now has a yearly output of more than ten million pounds. The French company had licensed the process in England, Belgium, Italy and Russia, and it had also been sought by German interests. In short, the value of the patented process had been recognized commercially in the important European industrial countries.

Conclusions of Law

1. Plaintiff has full title to the reissue patent in suit.

2. The Court has jurisdiction in the suit.

3. Claims 8 and 9 of plaintiff's reissue patent No. 20,370 are valid.

4. The specifications of the original Lefort patent do not fail to describe the alleged invention in "full, clear, concise and exact terms" as required by Section 4888 of the Revised Statutes (35 U. S. C. A. Sec. 33).

5. Plaintiff's patent is not invalid for failure of plaintiff to file disclaimer of claims 2 and 4, 5 and 7, which

are not at issue in the present suit and which are of a much narrower scope; for a patent will not be invalidated for mere failure on the part of the patentee to disclaim prior to some judicial decision upon the subject matter, i. e., upon one or more of the claims, of the patent.

6. While, under French or British law, it may have been appropriate to accord, as was done, the dignity of a patent to the various alleged distinctions in the specifications of the French patents and their additions, and of the British patents, still this Court is not required to give any conclusive effect to the same in this proceeding.

7. The clause in claim 8 (broader than the corresponding one in claim 9) calling for "material having the catalytic characteristics of silver" does not render claim 8 invalid on the ground that this clause is too broad in that it might include all future discoveries in this catalytic field,—conceivably catalysts having no silver content whatever,—because this clause must be read in the light of the specifications which in turn in their broadest aspects are to be interpreted as embracing besides silver only such other metals as are actually enumerated or were actually known at the time of the original application.

8. The original patent was sufficiently inoperative for the protection of the alleged invention to afford a statutory basis for the reissue of the patent. It is not necessary, in order to warrant a reissue of a patent, that the original patent be inoperative in the literal sense.

9. The power to reissue a patent may be exercised when the original patent is inoperative in the sense that its specifications are defective or insufficient, or when the claims are narrower than the actual invention of the patentee, provided the error has arisen through inadvertence or mistake, and the patentee is guilty of no fraud or deception; and provided, of course, that the reissue shall be for the same invention as the original patent, as disclosed by the specifications and claims of the original, and that due diligence is exercised in discovering the mistake in the original patent. A delay of a year and a half after the original patent was issued is not too long.

10. Defendant infringes claims 8 and 9 of plaintiff's reissue patent No. 20,370, in that the process followed by defendant in producing ethylene oxide is not materially different from the process of claims 8 and 9 of plaintiff's reissue patent No. 20,370.

11. A patentee having consciously accepted with satisfaction a patent of given scope, may not remain idly by and allow his competitor to build up a business outside the scope of the patentee's claims and thereafter, with a desire to capitalize and take from his competitor what the latter has innocently created or developed, secure a reissuance of the patent so as to embrace the domain of his competitor.

12. If in making large investments the officials of the defendant company were too hasty or ill-advised with respect to possible conflict between their rights or interests and those of the plaintiff, this is not something that a court of equity can relieve against. Indeed, it is precisely the sort of thing which a court of equity should condemn, not condone.

13. Defendant's operations cannot be considered as entitled to protection up to the date of the application for the reissue or to the date of its granting, since all such operations were entirely in the experimental and development stage as distinguished from commercial operations.

WILLIAM C. COLEMAN,
United States District Judge.

October 30, 1940.

UNITED STATES DISTRICT COURT

DISTRICT OF MARYLAND

CARBIDE AND CARBON CHEMICALS CORPORATION, *Plaintiff*, *vs.* U. S. INDUSTRIAL CHEMICALS, INC., *Defendant.*	CIVIL ACTION FILE No. 249

Order

It is hereby ORDERED by the District Court of the United States for the District of Maryland, this 20th day of May, 1940, that Dr. J. C. W. Frazer of Baltimore, Maryland, is hereby appointed to serve as a neutral expert witness in this cause to advise the Court with respect to reissued letters patent in suit No. 20370, the process of the Defendant in its relation thereto and the disclosures of the prior art in their relation to the said reissued patent in suit.

IT IS FURTHER ORDERED that the said Dr. Frazer shall in advance of the trial of this cause make such tests and experiments in respect to any and all of the foregoing matters as he may deem desirable and appropriate, affording, so far as is feasible and as he may deem desirable, to representatives of both parties and their counsel the right to be present at any such tests and experiments; and shall, at the request of either party attend such inter-partes tests and demonstrations respecting any of the foregoing matters as may be made prior to the trial of this cause; and may suggest to either party that that party make such tests and demonstrations as he may consider pertinent to any of the issues of the case and at which tests or demonstrations he and representatives of the other side shall have the right to be

present; so that he shall be in a position to advise the Court with respect to all of the aforesaid and his conclusions thereon at the trial, which advice shall be given in the form of sworn testimony in open court and subject to cross examination by each of the parties, and to the objections of counsel.

AND IT IS FURTHER ORDERED that the fees and expenses of the said Dr. Frazer shall be fixed by the Court and paid in the first instance equally by the parties, and finally as part of the taxable costs herein.

AND IT IS FURTHER ORDERED that the parties shall promptly furnish to Dr. Frazer the following documents:

1. The reissue letters patent No. 20370 in suit.

2. The original patent No. 1998878.

3. Defendant's statement as to its process, a copy of which has been furnished to Plaintiff.

4. A corresponding statement of Plaintiff's operations, a copy of which is to be supplied to Defendant at the same time.

5. Copies of the prior art set up as anticipations in Defendant's answer as amended on which Defendant will rely at the trial, together with translations of such as are not in the English language, it being understood that nothing herein shall abridge the right of either party to refer to other publications at the trial as indicating the state of the prior art.

6. File wrapper of reissue patent 20370.

7. File wrapper of original patent 1998878.

8. French patents Nos. 729952 and 739562 and the Additions thereto, together with translations of them.

9. British patents Nos. 402438 and 402749.

WILLIAM C. COLEMAN,
United States District Judge.

Dated: May 20, 1940.

AMENDMENTS TO PARAGRAPH 6 OF DEFENDANT'S ANSWER

6. Further answering, defendant avers that said Reissue Letters Patent No. 20,370 were and are invalid and void for each of the following reasons:

* * * * * *

g. Because plaintiff was fully informed and fully aware that said Reissue Letters Patent contains claims, in particular claims 2, 4, 5 and 7 thereof, for subject matter which is not disclosed in the specification thereof, and plaintiff has unreasonably neglected and failed to disclaim said claims or any one or more of them.

(Amendment filed September 29, 1939)

h. Because plaintiff was fully informed and fully aware that said Reissue Letters Patent contain claims, in particular claims 4 and 5 thereof, for subject matter which was specifically disclaimed by the patentee Lefort in an oath signed and sworn to by him under date of March 30, 1937, and filed in the Patent Office in furtherance of his application for the said Reissue Letters Patent, and plaintiff has unreasonably neglected and failed to disclaim said claims or either of them.

(Amendment filed April 19, 1940)

TESTIMONY OF DANIEL PYZEL

Thereupon——

DANIEL PYZEL, a witness of lawful age, produced on behalf of the defendant, having been first duly sworn, was examined and testified as follows:

Direct Examination.

By Mr. Edmonds:

Q. Mr. Pyzel, you have stated your name. And will you please give your place of residence? A. My place of residence is Piedmont, California.

Q. And do you spend much of your time in New York? A. I spend about half of my time in New York, and half of my time in California.

Q. And are you in the employ of an industrial organization? And if so, will you state in what capacity? A. I am in the employ of the Royal Dutch Shell, the Shell Union Oil Company, and the Shell Chemical Company. Do you want the capacity?

Q. Yes, will you state that? A. I am Vice-President and Director of the Shell Union Corporation; I am Vice-President and Director of the Shell Chemical Company; and a director of the Shell Development Company.

Q. (By Mr. Edmonds) What is the relation of the Shell Development Company to the Shell Union Oil Company? A. The Shell Development Company is a company that occupies itself with research work and patents.

Q. That is its field of operations. What is its relation to the Shell Union Oil Company? A. The Shell Development Company does the research work for the operating companies.

Q. Do these companies with which you are connected, and more particularly the Shell Union Oil Company, have any relation with industrial organizations abroad? And if so, will you state what they are? A. The Shell Union—all these Shell companies in this country are subsidiaries of the Royal Dutch Shell Company in Europe. This same combination of Royal Dutch Shell has utilities in Europe. One of them is the Bataafsche Petroleum Maatschappy over there.

Q. May we refer from now on to that company as B. P. M.? Will that be convenient? A. It will be much more convenient.

Q. Had you finished? A. The B. P. M. is the subsidiary of the Royal Dutch Shell, which is in charge of all the production and refining and operation of plants, and is also in charge of the research and development work, as far as it is being done and carried out in Europe.

Q. Now, would you state whether or not B. P. M. in Europe corresponds to the Shell Development Company

in the United States, in the Dutch Shell organization? I do not mean specifically, but in a general way? A. Yes, the development department of the B. P. M. in Europe does the same work as the Shell Development Company in this country, yes.

Q. And is there any more direct connection, as, for instance, an ownership connection, between Shell Development and B. P. M.? A. The Shell Development in this country is owned 50 per cent. by the Shell Union Oil Corporation in New York, and 50 per cent. by the B. P. M. abroad * * * [311-313].

* * * Q. Did your Dutch Shell companies or any one of them at any time have an option to acquire the application for the Lefort patent? The original patent of which the reissue herein suit is a reissue? A. Yes, sir.

Q. At about what time did you get that option and how long did the option continue? A. The option was acquired in, if I remember right, about April, 1933, and ran to August 1, 1933, and then was extended until the 31st of December of that year.

Q. How did the matter first come to your attention? A. It came first to our attention through correspondence with our friends in The Hague.

Q. Now, will you proceed in narrative form, if you will, and state what happened from that time on, giving a narrative of it? A. A research group investigated it. This patent was offered by Societe Francaise de Catalyse Generalisee, and our research group sent some of their men over to the laboratories of this French company to have this process demonstrated to them and to get acquainted. The reports on these investigations were in due course sent to us,—— * * * [316-317].

* * * It was then reported by our associates in Holland that we could obtain a license agreement under those patents under certain conditions * * * [318].

* * * And at the same time they sent us a full report on the experimental work that was shown by the French inventors to the chemists of our laboratory.

The conclusion of these reports was that the value of the invention was completely in the catalyst employed,

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NOTE: Figures in brackets refer to pages of typewritten record.

and, therefore, before we decided we could go into this proposal on this side we thought it was necessary to investigate whether the patent, which at that time was only an application, would give us sufficient protection if we were going to use that patent. The difficulty was that in these experiments nothing was told about the character of the catalyst, and as our patent department here was of the opinion that unless that catalyst was properly disclosed in the patent it would not give us sufficient protection, we set our men to work to find out whether, with the disclosure in the patent application and in the French patents, it would be possible to operate this process.

This work was carried on more or less simultaneously at our Holland laboratory and in our laboratories in California, with the result that with data, as they were in the patent and in the French patent and in the American patent application, we found it was impossible to carry out the process.

In order to have sufficient time to investigate that, our friends on the other side asked for an extension of the option from the 31st of August, 1933, to the 31st of December which, after some difficulty, we obtained from the French company.

The French company did not at that time understand, and wrote us so, why the option should be extended. They said, "If you want to investigate we have to admit —we have to warn you that the data given in the patent application"—— * * * [318-320].

* * * As I said, the French company wrote us that they thought it was a waste of time because with the data in our hands in the patent application, we would not be able to get the results that the process could give if we had all the details of how to make or how to use that patent.

The Court: I do not understand that last. Will you state that again?

Mr. Edmonds: Will you restate that to the Court so that the meaning will be unmistakably clear?

The Witness: The French company did not think it necessary in the beginning to give an extension of

the option because the option could only be, in their opinion, an extension could only be for the purpose of allowing us to do more research work, and they said in their letters that further research work would not give us any result as, with the data in our hands, that is, the statement in the French patents—I mean in the American patent application, it would be impossible to obtain the results.

The Court: You mean that the owners admitted you could not get results with their own work, with their own formula?

The Witness: Yes, sir, the disclosures in the patent application.

By Mr. Edmonds:

Q. Did they tell your representatives who went to the French company what the catalyst was? A. No, they refused to tell that.

Q. Your representatives tried to get that information, did they not? A. We did.

Q. And it was after that unsuccessful effort to find out what the catalyst of the French company was and after finding the information in the patent application itself insufficient, that the French company wrote to you what you said they wrote? A. Yes, sir.

Mr. Edmonds: Does that clear that up, your Honor?

The Court: Yes, I think it does. The inference to be drawn from that, I suppose, is that they wanted you to take it or leave it, so to speak? In other words, if you wanted to enter into a license agreement you would take the patent, but they were not going to disclose anything more unless you did enter into an agreement with them. That's what it comes down to, isn't it?

The Witness: Yes, they only wanted to give us the full information after we should have signed an agreement, for which we would pay so much and pay a certain royalty.

The Court: Yes.

Mr. Edmonds: But involved in that is an admission that the description in the application was insufficient.

Q. Now, will you proceed with the narrative? You were speaking of the research work that went on in Holland and in this country. A. We continued our research work and used various kinds of silver catalysts in order to—in an effort to duplicate the work that the French company had shown us, but both in our laboratory in Amsterdam and our laboratories in California we were not successful. Numerous silver catalysts were used but they had practically no effect and with no formation of ethylene oxide, and this was an important point for us because it was the opinion of our patent department, our company's patent department here, that in that case a license under the patent of the French company would not protect us sufficiently, and that was one of the reasons we finally broke off the negotiations.

Q. Now, was the research work at The Hague continued during the fall and winter of 1933? A. It was continued in 1933 and in the beginning of 1934, and apparently the work was continued even after the option officially lapsed and the work was continued in this way: that a certain process was tried out in the laboratory of the French company and on a certain gas mixture containing ethylene that we had available in one of our plants in California, and for that reason the work was continued.

Q. Was there some further contact with the French company along in the winter of 1933 and 1934, I mean, work with them right at their plant? A. Yes. These experiments with the gas of the composition that we had available in California were continued on in their laboratories.

Q. And was a report on that written? A. A report on that was written, a full report.

Q. And did the work at The Hague go on beyond that, in point of time, and continue even after that visit to the French company? A. Yes, our laboratory in Amsterdam continued to work to find a suitable catalyst for this process.

Q. Did the laboratory succeed in doing that finally? A. It succeeded in finding and Van Peski obtained a patent on that special catalyst in this country.

Q. Will you tell us to the extent that you know about it whether or not water was one of the reactants put in the reaction chamber in the method of the Dutch Shell Company to comprise the process as described in the application of Lefort for French and United States Patents? A. Do you mean in the experiments made together with the French company?

Q. Yes. A. Yes, in all those experiments water in quite considerable quantities was used.

Q. For instance, in the experiments made at the French company's plant in the winter of 1933 to 1934 at a time when, as you said, you sent some Shell gas over there for use in the demonstration, was water one of the reactants put into the reaction chamber then? A. Yes, sir, water was added in considerable quantities, if I remember right, eighty or one hundred grams of water per one hundred litres of gas.

Q. Roughly, can you give what percentage of the whole mixture introduced into the reaction chamber is represented by the things you have just given, what percentage of total volume? A. The volume of the steam generated from that water that was added was equal or more than the volume of the other gases, so that the mixture of gases and steam would constitute more than 50% of water vapor.

Q. I want you to identify some documents, if you will. You spoke of the initiation of this matter of an option to your company to get a license under this Lefort U. S. application. Will you state whether that document I hand you bears on that? A. Yes, it does.

Q. Is that a copy of a letter written by you? A. It is a copy of a letter written by me to Mr. Masthoff of the company's office in the Hague. He is in charge of chemical developments * * * [320-327].

* * * Q. The original went to Holland presumably. It is there, if it is anywhere? A. Yes, it is there, it should be there * * * [327-328].

Mr. Edmonds: * * * We will offer in evidence the copy just introduced or identified by the witness as Defendant's Exhibit No. 42.

(Copy of letter written by Mr. Pyzel to Mr. Masthoff marked "Defendant's Exhibit No. 42.")

By Mr. Edmonds:

Q. Mr. Masthoff, as far as you know, is he the chief of research of B. P. M. in Holland? A. Whatever is left of it at present.

Q. Did you get a reply to the letter which you sent and which has just been offered in evidence? A. I guess I got a reply in which Mr. Masthoff tells us what they had done so far with the French company.

Q. Is that the original of the reply? A. Yes, that is.

Q. Addressed to you and signed by Mr. Masthoff? A. It is addressed to me and signed by Mr. Masthoff.

Q. And you received it shortly after the date that appears? A. I received it on July 8th, 1933.

Q. You will notice at the end there reference is made to a number of enclosures that were to be forwarded with it and presumably were, one of them is a copy in French of the U. S. Lefort application and I ask you whether the document I now hand you is that particular enclosure received by you with that letter? A. Yes, it is.

Q. I believe the letter also makes reference to a copy of the U. S. application in English and I will ask you if the document I now hand you is the copy of the application in English? A. Yes, it is.

Mr. Edmonds: I offer these three documents in evidence, the letter of July 28, 1933 from Mr. Mastoff to Mr. Pyzel as Defendant's Exhibit No. 43, the copy in French of the application of Lefort as Defendant's Exhibit No. 44 and the copy of the application in English as Defendant's Exhibit 45.

(The three documents indicated, letter of July 28th, 1933 from Mr. Masthoff to Mr. Pyzel, copy in English of the application for the Lefort patent and copy of the application in English marked "Defendant's Exhibits 43, 44, and 45" respectively.)

Q. Now, this letter which has just been marked Defendant's Exhibit 43 refers also to a report No. 5205 as enclosed with the letter and I ask you whether the document which I now hand you is that report? A. That is the document.

Mr. Edmonds: I will offer this report in evidence as Defendant's Exhibit No. 46.

(Report No. 5205 marked "Defendant's Exhibit No. 46.")

Q. Will you state just what this report forming Exhibit 46 is? A. It is a report by Doctor Langedijk of the company in Amsterdam of his visit to the Societe Francaise de Catalyse Generalisee, to their laboratory where this process of direct oxidation of ethylene to ethylene oxide was demonstrated to him.

Q. At the conclusion of the visit of Doctor Langedijk to the S. F. C. G. Company, was any arrangement made for a further meeting of representatives of the B. P. M. and the French company in Holland? A. Yes, there was.

Q. Did that meeting take place? A. The meeting took place.

Q. Is this document I now hand you a report of occurrences at that meeting? A. Yes, it is.

Q. Is that document, that particular one, the one that was sent to you with this letter of June 28th, Exhibit 43? A. Yes, it was.

Mr. Edmonds: I offer in evidence the report of the meeting of the representatives of the French company and the B. P. M. as Defendant's Exhibit No. 47.

(Report of meeting of representatives of French company and B. P. M. marked "Defendant's Exhibit No. 47") * * * [328-331].

* * * Q. Now, I hand you another document and ask you to state what that is? A. This is a letter from Mr. Masthoff in the Hague to me.

Q. Dated what and received by you when? A. That was received on July 20th, 1933.

Q. Now, that letter states at the end of it, it lists at the end of it certain enclosures that went with it. Did you receive those enclosures that went with the letter? A. Yes. The first enclosure is a letter from the French company to our friends in The Hague; the second enclosure is the reply of our friends in The Hague to the French company and the third enclosure, which is a memorandum of our Patent Department in The Hague on the subject.

Mr. Edmonds: I will offer in evidence this letter of July 6th, 1933 just identified by the witness, together with two of the three enclosures; that is the letter from the French company of June 18th, 1933 and the letter in reply to that dated July 5, 1933, and I would like to state that the third of the enclosures we have here and he is welcome to it at any time——

But being a report of the Patent Department of the B. P. M., it seems to me that the plaintiff here might have a proper basis for objecting to it, so I am not offering it in evidence; but they can see it; and if they have no objection to it it will be offered in evidence.

Mr. Watson: I will take it now, if you please.

Mr. Edmonds: Will you mark this exhibit, the letter of July 6, 1933, as Defendant's Exhibit No. 48.

(Letter dated July 6, 1933, marked "Defendant's Exhibit No. 48.")

Mr. Edmonds: I also offer in evidence translations into English of these two letters in French which accompanied Defendant's Exhibit No. 48.

(Translations of letters marked "Defendant's Exhibit No. 49.") * * * [334-336].

* * * Q. (By Mr. Edmonds) Look at the document that I now hand you, dated July 17th, and state whether or not you received that from the B. P. M., and with it the enclosures that are annexed to it (handing papers to witness). A. Yes, I did.

Mr. Edmonds: I offer that in evidence as Defendant's Exhibit No. 50.

(Letter dated July 17th, and annexed enclosures, marked "Defendant's Exhibit No. 50.")

Mr. Edmonds: The two letters annexed to this Exhibit No. 50 are in French; and so I present translations of them as Defendant's Exhibit 51.

(Translations marked "Defendant's Exhibit No. 51.")

Q. (By Mr. Edmonds) Look at the document I hand you now, July 25th, with one letter attached to it (handing papers to witness). Did you receive that letter at about that time? A. Yes, sir, I did.

Q. And the enclosure annexed to it? A. Yes.

Q. That particular paper was annexed as the enclosure? A. Yes.

Mr. Edmonds: I offer that in evidence as Defendant's Exhibit No. 52.

(Letter dated July 25th, and annexed enclosure, marked "Defendant's Exhibit No. 52.")

Mr. Edmonds: I also offer in evidence a translation of the letter in French, as Defendant's Exhibit No. 53.

(Translation marked "Defendant's Exhibit No. 53.")

Mr. Edmonds: Now, after you received these several letters what did you do next? And did you confer with any one connected with the research department of Shell development?

A. Yes, the research department of the Shell development, to do a certain amount of work to find out whether with data in the French patents—I mean, the American patent application, they could carry out this reaction.

Q. And did Shell development proceed under Mr. Williams' direction to perform that research? A. Yes, they did.

Q. And I suppose that was generally under Mr. Williams' charge, if so, who had charge of it under him? A. Mr. Williams is the head of the laboratories, and he instructed Dr. Groll to undertake this work with the group that he had. Dr. Groll was the head of a group of chemists.

Q. And the work was done and the report of it made to you? A. Yes, it was.

Q. Do you remember in what period the work was done? A. The work was done in August, 1933.

Q. Now, I ask you what is the document I now hand you? A. This is a monthly progress report on the work done in the month of August, 1933, by the group of chemists working under Dr. Groll in our laboratories in California.

Q. And you saw it at about the date it bears? A. Oh, yes * * * [345-349].

* * * Mr. Edmonds: I offer in evidence the title page of this report No. 1759, and page 68 of it, that being the only page of it that relates to this matter of ethylene oxide. But the balance of the report counsel can examine and satisfy themselves that it has no relation to anything else * * * [349-350].

* * * Q. Is that the original document, that mimeographed copy? A. Yes, that's the way in which our laboratory reports are issued because of the large number of copies that are required.

Q. On some of these reports you put right on the title page to whom copies are to go, do you not? A. Yes, sir.

Mr. Edmonds: I would be glad to keep that copy of the full report so that if counsel will agree that photostat copies may be substituted, I would like to do that.

I offer in evidence the two pages of the report, the title page and page 68 of the report itself, as Defendant's Exhibit 54.

(Title page and page No. 68 of Report No. 1759 marked in evidence, "Defendant's Exhibit 54.")

Q. Now, will you state what this document is I hand you? A. This is a copy of a cablegram which I sent to our friends in The Hague.

Q. On the date that it bears, August 29? A. Yes, sir.

Q. And in that cablegram did you record very briefly a preliminary opinion that you had arrived at by that date? A. Yes, I did.

Mr. Edmonds: I offer in evidence a cablegram just referred to by the witness as Defendant's Exhibit 55.

(Cablegram of August 29 marked, "Defendant's Exhibit 55.")

Q. Will you look at this document and tell me what it is? A. This is a copy of a cable I sent to the B. P. M. to do the work about a month later.

Q. Now, is it in that telegram that you referred to sending over some Shell gas for experimentation? A. Yes, sir.

Q. And was that done? A. That was done.

Q. At or about that time did you receive any inquiry from B. P. M. about something further that B. P. M. wanted to know for their use in the experimentation that they were conducting?

(Witness does not answer.)

Mr. Edmonds: Well, if you don't recall just what I refer to I will ask you to look at the document I now hand you, and I will offer in evidence the cablegram of September 28, 1933, which the witness has identified as Defendant's Exhibit 56.

(Cablegram from Mr. Pyzel to B. P. M. dated September 28, 1933, marked, "Defendant's Exhibit 56.")

A. Yes, we asked our laboratory in Amsterdam to do some further work on these catalysts in order to find out any way to make the catalysts so that they would work, and the reply from our friends in The Hague was that they had already started experiments in Amsterdam for the reasons explained, and they asked us to telegraph the composition of the catalysts which we used in our experiments in the laboratories in California.

Mr. Edmonds: I will offer in evidence copy of this telegram of October 2 as Defendant's Exhibit 57.

(Copy of cablegram of October 2 marked, "Defendant's Exhibit 57.")

Q. And what is the document I now hand you? A. This is a copy of a letter which I wrote to B. P. M. in

The Hague in which various silver catalysts with which we had experimented in the laboratories in California are described.

Q. That is your compliance with the cable request that you just referred to? A. Yes.

Mr. Edmonds: I offer in evidence copy of Mr. Pyzel's letter of October 6th as Defendant's Exhibit 58.

(Letter from Mr. Pyzel dated October 6th marked, "Defendant's Exhibit 58.")

Q. Look at the letter which I now hand you dated October 2, 1936, and state what that is. A. This is a letter which Mr. Masthoff of the B. P. M. in The Hague sent to me in California.

Q. Received by you in the regular course of the mail? A. Yes, received ten days after it was mailed in The Hague.

Q. And as received did it have attached to it the enclosure that is attached to it now? A. Yes, it did.

Mr. Edmonds: I offer in evidence this letter of October 2, 1933, together with the letter in French attached to it as an enclosure, as Defendant's Exhibit 59.

(Letter from B. P. M. to Mr. Pyzel of October 2, 1933, together with letter in French marked, "Defendant's Exhibit 59.")

Mr. Edmonds: I offer in evidence a translation of the letter in French, which is the enclosure with this letter of October 2, 1933, this translation to be, Defendant's Exhibit 60.

(Translation of letter in French enclosed with letter of October 2, 1933, marked, "Defendant's Exhibit 60.")

Q. Will you look at the copy which I now hand you and state what that is? A. This is a copy of letter which I sent to the B. P. M. at The Hague on October 19, 1933.

Mr. Edmonds: I offer this copy in evidence as Defendant's Exhibit 61.

(Letter from Mr. Pyzel to the B. P. M. in The Hague on October 19, 1933, marked, "Defendant's Exhibit 61.")

Q. I now hand you a letter dated October 20, 1933. Will you state what that is and also what the enclosure with it is? A. This is a letter sent by B. P. M. in The Hague to me in San Francisco.

Q. Received by you in the regular course of the mail? A. And received by me ten days after it was mailed.

Q. And what is the enclosure? A. The enclosure is a report of a discussion between Mr. Francon of this French company and some of the gentlemen of the B. P. M. in The Hague.

Mr. Edmonds: I offer in evidence this letter of October 20, 1933. that the witness has just identified, together with the copy of their report in answer to it as an enclosure, as Defendant's Exhibit 62.

(Letter of October 20, 1933, from B. P. M. to Mr. Pyzel, together with enclosure, marked, "Defendant's Exhibit 62.")

Mr. Edmonds: The enclosure with that letter is in French, so I will offer the translation of it as Exhibit No. 63.

(Translation of letter in French enclosed with letter of October 20, 1933, marked, "Defendant's Exhibit 63.")

Q. Now, at or about the time that we have now come to, did Mr. Masthoff come to this country? A. Yes, he came to this country.

Q. And did you meet with him and confer on various subjects, including this one? A. Yes, I did.

Q. Did you two collaborate in writing anything in the way of instructions to the B. P. M.? A. Yes, we did.

Q. Look at the copy of the letter of November 3, 1933, which I now hand you and state what it is. A. This is a copy of a letter sent by Mr. Masthoff from The Hague who at that time was in California, to Mr. Jacobson of the B. P. M. in The Hague, on the subject of ethylene oxide.

Q. In that letter, towards the end, does that recall to your mind any reference as to how you and Mr. Masthoff conferred on this matter? A. We discussed whether this process for which the French company offered us a li-

cense would be of any use for our purposes especially in comparison to other processes of making Ethylene Glycol and our conclusion was that the other processes were preferred.

Q. I take it that the original of that letter was signed by Mr. Masthoff? A. This letter was signed by Mr. Masthoff, yes, but it was the result of a discussion between Mr. Masthoff and me and he refers to that in the first paragraph of this letter and also in the second from last paragraph.

Q. The letter represented your views at the time as well as his? A. Yes, it was our joint opinion.

Mr. Edmonds: I offer this copy in evidence as Defendant's Exhibit No. 64.

(Letter referred to marked "Defendant's Exhibit 64.")

Q. Now, will you look at the document I now hand you and state what that is? * * * [351-360].

* * * The Witness: This is the condensed report on the work of the research laboratory in Emeryville, covering the last nine months of 1933.

By Mr. Edmonds:

Q. This particular volume is a rather large one covering a great many subjects other than ethylene oxide? A. Yes, it does, it covers all the work that has been done during those nine months in the laboratories.

Q. I wish you would state whether or not it is a fact that the only references to this ethylene oxide matter contained in the report are on pages 42, 44, 45 and 46. Is that a fact? A. Yes, it is.

Mr. Edmonds: I will offer in evidence photostat copies of the title page of this report and of pages 42, 44, 45 and 46 * * * [360].

* * * Q. Now, will you look at the binder which I now hand you and state what is contained in that? A. This is a binder of the laboratory in California containing monthly reports of the work done in the laboratory in

Amsterdam on the subject of production of ethylene oxide.

Q. What period do the monthly reports cover? A. October, it starts in October of 1933, December, 1933 and goes on to January, 1935.

Q. Did you receive copies of these reports as they were issued? A. Yes, sir.

Q. You personally? A. I got these reports personally and distributed them from my office.

Q. So they went to Emeryville in addition to going to you? A. Yes.

Mr. Edmonds: I offer in evidence this collection of reports just identified by the witness as Defendant's Exhibit 66.

(Collection of reports of work done in laboratories in Amsterdam marked "Defendant's Exhibit 66.")

By Mr. Edmonds:

Q. Can you state from the papers which I now hand you when these monthly reports were received by you? A. These monthly reports, for instance the monthly reports of the Amsterdam Laboratory of October and November 1933 were received here in California in March, 1934. For the work done in January and February of 1934 we received them in June of 1934. And for the work done in March and April 1934 we received the reports in September, 1934.

Q. Now, will you identify this document which I hand you which has on the front of it the original of a letter dated May 28th, of 1934? A. This is a document which was received in California on June 12th, 1934 and contains the reports of the work done in the presence of two of the chemists in the Amsterdam Laboratories, Mr. Al and Mr. Langedijk in the laboratories of the French company in order to find out whether the certain gas mixture which is produced at one of our plants in California and which contains etheylene may be converted into or could be used for the purpose of producing ethylene oxide by this process. These experiments were

made in January, 1934, from January 9th to January 24th and this is a full report on the work that was done at that time.

Q. Did you explain what gas was used in making these tests covered by the report? A. It was what we call an ethylene fraction, which is produced in the Shell Chemical and Ammonia plant in California and which contains around 50% of ethylene.

Q. Was it that particular gas referred to in some of the cablegrams that you identified as being sent over? A. Yes, it was.

Q. And a copy of this report came to you at about the time it was submitted, did it not? A. Yes, this work was done on my request.

Q. And did you examine the report? A. I did.

Q. And you have retained until today your familiarity with it? A. Yes, sir.

Q. And on that basis what can you say about the water that was introduced into the reaction chamber in the course of the operations covered by the report? A. All this work was being carried on in the laboratories of the French company. The procedure followed was as indicated by the inventor and in all the runs that were made and all the efforts that were made to obtain good results, to improve results, always a considerable quantity of water was used.

Q. Can you express that in figures, not exactly, but reasonably accurately, as, for instance, the percentage of the volume of water which went into the reaction chamber? A. Well, it is in the direction of 80 or 100 grams and sometimes more and sometimes a little less per 100 litres of gas, and that works out always to at least 50% of the mixture of gases that goes into the reaction chamber as water vapor.

Q. This experimental work at the French plant covered by this particular report was some nine months later than the work recorded in one of the other reports that you identified here this morning? A. Yes, the first report was on work done if I am not mistaken, April 1933 and this is January, 1934.

Q. Is there any statement in this report which you have in front of you about the amount of water that went into the reaction in the course of this 1934 experiment as compared with the amount that went in in the 1933 experiments of nine months earlier. A. The above statements in this report on that point——

Q. Just state the general purport of them? A. Here, for instance, per 100 litres of this mixture of Shell point gas, Shell point is the name of the ammonia plant they have here, about 100 grams of water had to be used. There are indications in this record that the reduction of the reaction temperature has a favorable effect.

Q. Isn't there some statement there that the amount of water introduced in 1934 was a little less? A. I remember that there is a statement that the amount of water introduced during these experiments was less than what was used in the experiment of 1933, but where it is exactly, I don't know.

Mr. Edmonds: I offer in evidence a photostat copy of this report which the witness has just identified as Defendant's Exhibit 67 and will ask counsel to agree that this photostat copy may be accepted in lieu of the original, it being understood that the original will be here for examination at any time.

(Photostat copy of report above mentioned marked Defendant's Exhibit 67.)

Mr. Watson: You don't have to keep repeating that, we will always take copies.

By Mr. Edmonds:

Q. Now, I think you spoke of the Van Peski patent. Is this the Van Peski patent, 2040782, which you referred to? A. Yes, this is the patent.

Q. That covers the work done at the B. P. M. Laboratory along about 1934? A. Yes, it does.

Mr. Edmonds: I offer in evidence a copy of the Van Peski patent 2040782.

(Copy of Van Peski patent 2040782 marked "Defendant's Exhibit 68") * * * [362-368].

* * * Q. Now, you mentioned Dr. Groll, Mr. Pyzel, as one of the research men in the laboratory. When did he leave Dutch Shell and where did he go? A. I do not quite exactly remember when he left.

Q. Well, say a year ago? A. Say about two years ago, and he went to Germany.

Q. And he has been wholly disconnected from the Shell Company since then? A. No, he first worked in Germany with an oil company that belonged to our company.

Q. Oh, I see, but so far as you know he is in Europe now, and probably in Germany? A. Oh, yes.

Q. And you had something to do with the effort to get Dr. Langedijk to come over here for this litigation, did you not? A. Yes.

Q. About a month ago? A. Yes.

Mr. Edmonds: Now, I want to go into this other matter concerned with the objection that was presented by counsel. Where are those four reports?

Q. I wish you would state in some detail what, if any, system was adopted for the interchange of technical information between the Shell Development Company and B. P. M., pointing out to what extent the system that was adopted included the preparation of reports on items of consequence.

The Court: Now, that's the question I ruled out, isn't it, about an hour ago?

Mr. Edmonds: Yes, sir, because its bearing at the time did not appear, but its bearing does now, because the plaintiff has objected to the receipt in evidence of these documents, and they are receivable, as I see it, only if I meet the conditions of the statute, and this is designed to present the proof required by the statute making those documents admissible.

The Court: Well, gentlemen, as I understand it, the witness has testified as a high official of the Shell Company, that his company asked these technicians to look into the French patent and give the results of what they thought of it, whether it was worthy of being licensed,

and you have put in that correspondence, and the witness has stated that in effect the reports say, "We do not think so much of the patent." In other words, they recommend against their doing anything about licensing it.

Now, that's the sum and substance of the testimony. Now, I do not see any need of going into the internal relations of this or that company, or its relations with some other company. I do not see that that helps at all. I am letting in, subject to the renewal of the objection, I am letting in the prima facie proof and the correspondence, and it has been summarized by the witness. I understand you want somebody else to talk in more detail about the report. It seems to me that that is ample. I am not interested, for many reasons, in relation to this case, and I see no need to go any further into the history of the way these companies work; I am not interested in how they work, I am interested in how this thing works, the particular process.

Mr. Edmonds: May I ask two questions, using the words of the statute, by way of offering to produce that information which I conceive to be necessary to make these documents admissible? All I want to do is to comply with the conditions of the statute. The statute says if it shall appear that it was made in the regular course of any business, and that it was the regular course of such business to make such memorandum or record at the time——

The Court: But Mr. Pyzel has already explained in some detail that he ordered them, the experiments, or that they were ordered by his general direction, and that they were carried out, and he has discussed in a brief way what they amounted to. I do not see that you need anything else. I do not want to go in detail, it wouldn't throw any light on the facts, and that's what we want to get to, and we want to get there as briefly as possible.

Mr. Edmonds: I am faced, may it please the Court, with the fact that counsel for the plaintiff has put on the record an objection to the admissibility of these documents.

The Court: Well, I overruled the objection with the right to renew it later on, but I am now admitting everything that you put in, I don't know whether it has any real probative value or not, but I am letting it in on the basis it may have.

Mr. Edmonds: May I just make this statement for the record, then: that the defendant offers to prove by this witness that all the documents identified by him were made in the regular course of the business?

The Court: He has already said that. I recall that you asked him such a question—maybe not in those exact words—and Mr. Pyzel has stated that, and stated it several times, that's why I am letting it in.

Mr. Edmonds: I thought that was covered by the question which was ruled out initially, and which I repeated.

The Court: I am letting it on the basis that Mr. Pyzel had direction or he was one of the high officials who had the general direction over these laboratory experiments which were ordered either directly or indirectly by him for the purpose of determining whether his company would take out a license, would take out a license under these French patents.

Now, you have introduced a very elaborate chain of documents showing, as I understand it, that they went fully into this thing and made elaborate experiments and concluded that it was not worth taking out a license and therefore the matter was turned down by the technicians of the Dutch company, which Mr. Pyzel represents. Now, he has stated all that, and I am letting it in because of his position in the company and his general direction over these laboratory experiments, and that's all you need.

Mr. Watson: May I offer one more comment? For instance, here is one of these exhibits. We are getting a tremendous volume of them. So far as they go in I trust they will go in as physical exhibits that do not have to be reproduced in 50 copies on an appeal record.

Mr. Edmonds: Oh, I guess we can agree about that later on.

The Court: In other words, if, for whatever reason, Mr. Pyzel is not now requested to elaborate any further on these reports, I should say that your direct examination was about concluded.

Mr. Edmonds: It is, so far as I am concerned, in all respects except this one thing that gives me some concern.

Your Honor has admitted these documents, but suppose we were in a court of appeals and I make my argument based on these documents, and counsel then says, "Those should not have been admitted at all; my objection there was a proper one because there was no compliance with the conditions of Section 8695."

The Court: I think there has been a substantial compliance.

Mr. Edmonds: Well, could we abbreviate the matter by allowing me to make a statement on the record that we offer to prove by this witness that all of these documents were made in the regular course of business of his companies, and that it was the regular course of that business to make all of these memoranda and records?

The Court: Yes, you can ask him that question. I thought you had done that.

Mr. Watson: My objection goes beyond that point. My objection persists, I do not care what the language is of the statute, I think it is impossible to believe that this Court can take such documents from a witness who neither wrote them nor received them, nor understands what they were at the time they were done, and have them evidence of the facts recited in them. My objection is fundamental.

Mr. Edmonds: You can abbreviate this a great deal by saying you do not contend that these documents were not made in the regular course of business, or that it was not the regular course of business to make such records.

Mr. Watson: I can not admit that, Mr. Edmonds; some of this work was done in Holland, in Europe;

what is the materiality? What it has got to do with this case I can not imagine.

Mr. Edmonds: Well, that is another matter.

The Court: Well, I will allow the witness to answer the question, and I understand his answer is, Yes. It has already been put to him.

The Witness: That's right.

By Mr. Edmonds:

Q. You have stated that all of these records that you have identified here today were made in the regular course of the business of your Shell Development Company and the B. P. M.? A. Yes, sir.

Q. And was it the regular course of business of those companies to make just such memoranda and records? A. Yes, it was.

Q. And was it throughout the years prior to 1933, and has it been ever since? A. Yes, sir.

Mr. Edmonds: That's all.

The Court: Now, do I understand you are following this witness with some witness who did do some of the experimenting?

Mr. Edmonds: Yes, sir, all experiments done in August, 1933, and covered by the report which Mr. Pyzel identified, the report of the one for 1933; that man is here and we propose to put him on the stand.

The Court: Well, for the present, then, subject to your right to renew the objection as to the ruling, I think it would be more appropriate to limit the admission of the documents to the part that the witness present who is going to testify to them knows about. I think the letters are admissible, but as far as the reports go, I think they should be limited, in the production of them, to what the following witnesses or witness, who will follow, will speak about, and that partially meets Mr. Watson's objection.

Mr. Edmonds: I think the witness only knows about the work that is covered by one of the records——

The Court: Well, I think it is a more satisfactory way to proceed, and then you can renew your objection as to the other report following the hearing of the testimony with respect to the witness who made the particular laboratory experiment on the basis of the one he knows about. That is very much narrower than Mr. Watson means.

I think there is great weight to what Mr. Watson said. You cannot use a strict technical—you could not and should not require someone to rest without having an opportunity to ask the man who made the experiment why he used this or that quantity or this or that thing. It is not like a financial report where two and two make four. I think the statute has that sort of thing more in mind perhaps.

Mr. Edmonds: It certainly was directed among other things to entries but it goes way beyond that.

The Court: Yes, but it has to be given a reasonable interpretation.

Mr. Edmonds: And the Courts have already carried it way beyond that as, for instance, the special Court that ruled on the Manton case, where it received in evidence records of checks.

The Court: I will have to limit the admission as just stated. I think one of the grounds for being perhaps a little more liberal than usual is because of present war conditions and inability, the admitted inability to introduce in cases over here involving foreign work witnesses that would ordinarily be called but cannot for the time being on account of the conditions on the other side, but for the time being I am going to limit the admissibility to the correspondence and the one report about which you say you have a witness who can testify of his own knowledge * * * [381-393].

* * * Mr. Edmonds: What am I to understand from that, that the report on the test made with Shell gas in France in January of 1934, that is excluded? That is the report this witness said he studied and was familiar with. The detail in that report is like the detail that goes into an account book in a bank. No one person can be produced

to identify any of these details because they were made by——

The Court: Someone signed that report or rendered it, didn't he?

Mr. Edmonds: Probably a number of people collaborated in writing it.

The Court: The records of the company would show who submitted it, wouldn't they?

Mr. Edmonds: They would show various people who did the work, contributed their part to making up the report.

The Court: My present ruling is that I am excluding all of the scientific reports for the time being which cannot be followed up by testimony of some persons, someone or more persons who actually performed the experiments referred to or made some part of the final report bearing there on.

By Mr. Edmonds:

Q. Mr. Pyzel, in these monthly reports which you identified of the work at the B. P. M. laboratory from October, 1933 to April, 1934, will you tell us whether or not Doctor Langedijk did some of the work covered by these reports? A. Yes, I am quite certain that he did.

Mr. Watson: Are you guessing? Did you see him do it?

The Witness: No, but he reports that.

The Court: Is he here?

The Witness: He is the man we cannot get here on account of the war conditions.

By. Mr. Edmonds:

Q. He is the man you expected or thought you had arranged to get here, but he could not come? A. No.

Q. I see some of these reports indicate that some of the work was performed by a Mr. Al? A. Yes.

Q. Is he available for use here? A. No.

Q. Do you know where he is? A. In Holland.

Q. Some of the reports indicate that part of the work was done by Mr. Smithuysen? A. Smithysen.

Q. Where is he, do you know? A. In Holland.

Q. Who is Doctor Visser, whose name appears on some of the reports? A. He is one of the chemists in the laboratory in Amsterdam.

Q. Did all three of these men continue in the laboratory up to a month ago as far as you know? A. Yes, sir.

Q. How do these reports compare with reports which you have received from time to time since 1933 and reports which you received years prior to that?

Mr. Watson: I object to a question of that kind. It is calling for a conclusion of the witness. If the thing was material, Mr. Edmonds would have to produce these other records.

The Court: I sustain the objection and, Mr. Edmonds, I think I have made my ruling clear and will have to adhere to it. You can have an exception and you can renew your objection later on, but I will limit the introduction for the time being to the correspondence that has general relation, I understand, to this whole subject, and which has a bearing even though it may be indirect at times upon this one report or such other reports if there is more than one, which is going to be referred to by one or more witnesses who naturally had something to do with making it up.

By Mr. Edmonds:

Q. I want to ask you, you said the option to take a license under the U. S. Pending Application of Lefort ran up to December 31, 1933. Did your companies allow that option to expire? A. Yes, it had expired.

Q. And further work was done in January covered by one of these reports. Was that done under an extension of the option? A. Yes, I cannot tell you exactly but the option was informally extended because the work

was done together with the French people in their laboratories.

Q. And extended without any writing on the subject at all? A. None at all.

Mr. Edmonds: That is all.

Mr. Watson: Mr. Bissinger, you are familiar with these exhibits. Can you give a list of those which are admitted under the Court's ruling?

Mr. Edmonds: All are admitted except two, this one here and the big one here * * * [394-399].

The Court: What are the numbers of the ones that are excluded?

Mr. Edmonds: The numbers of the ones excluded are 66 and 67. Those two, we understand, are excluded. What is covered by this one in general form, this monthly progress report, is work which is also covered by the detailed report not yet presented on which this other witness will testify.

The Court: Let's get on, gentlemen.

CROSS EXAMINATION.

By Mr. Watson:

Q. Where were you born, Doctor Pyzel? A. Excuse me, I am not a doctor.

Q. Where were you born, however? A. In Holland.

Q. How long have you been in this country? A. Twenty-two years.

Q. Are you here under subpoena? A. No, I am not.

Q. You are not here under any kind of Court order? A. No, I am not.

Q. You came of your own free will? A. Yes.

Q. Who are your higher officers in this country? A. Well, I would say Mr. Vanderwoude, the president of Shell.

Q. Did he tell you to come here? A. No * * * [399-400].

* * * Q. Do you know the Shell Company is interested in the outcome of this suit? A. We are not as far as I——

Q. Answer my question. A. Do I know?

Q. Yes. A. Not directly.

Q. What do you mean by not directly? You would like to go into the business of making ethylene oxide? A. We would like to be able to do that, yes.

Q. And you would like to do it by a catalytic process of passing ethylene and air over silver? A. We would like to do it by a catalytic process of direct oxidation.

Q. Using silver? A. I don't care, anything that is a good catalyst.

Q. If the Lefort patent is held invalid, it is your intention to go into that business? A. We may.

Q. How long have you known of the existence of the Lefort U. S. Patent? A. The Lefort U. S. Patent?

Q. Yes. A. I think about from the time it issued.

Q. How long about the Lefort Reissue patent, the one here in suit? A. Well, I can't exactly tell. I get all these patents in the form of abstracts over my desk and if they especially interest me I look at them and, if not, I only look at the abstract as they issue.

Q. When did your option to acquire the American rights expire? A. Officially on the 31st of December, 1933.

Q. Do you know your companies tried to open negotiations to get a license under the Reissue patent? A. I don't remember.

Q. Are you a chemical engineer skilled in the process of catalysis? A. I am a chemical engineer. I know something of the process of catalysis. How skilled I am, I don't know.

Q. Would you call yourself a skilled worker in the field of catalytic processes in 1933 for example? A. I think I know more about it than a lot of other chemists.

Q. That is not my question. We will proceed faster if you will answer the questions. What had been your experience up to that time in processes of gas phase reactions by catalysis? A. One of our experiences is a large ammonia plant in California which is used as a catalytic process.

Q. As a Haber process? A. No, and where purification of gases takes place by catalytic processes.

Q. What are they? A. The removal of carbon dioxide from the mixture of hydrogen and nitrogen and admixtures of ammonia from admixtures of hydrogen and nitrogen.

Q. Is that the extent of your experience? A. That is the extent of a very intimate experience. There are further processes, oil, in which an enormous amount of work on catalysis has been done and on which I have always been kept informed and which I had to study in the course of my duties.

Q. That is prior to 1933? A. Yes, I started in 1929.

Q. You were informed by the Societe Francaise de Catalyse Generalisee that the Lefort process included the use of a silver catalyst, weren't you? A. Yes, sir.

Q. And you were informed that the process was conducted at a temperature of 150 to 400 degrees centigrade, weren't you? A. Yes.

Q. And you were informed also that the French companies patent rights in foreign countries had been acquired in England, for example, weren't you? A. I don't remember.

Q. When did you find out that the Distillers Company Ltd. of England owned the British patents to the Lefort process? A. Now, I remember, we received information from the company here in New York.

Q. So you knew that the British Distillers Company was operating the Lefort process in England? A. Well, whether they were actually operating I don't know, whether that was in the information.

Q. And the German I. G. acquired the corresponding patent rights in Germany to the Lefort process, do you know that? A. I didn't know that * * * [401-405].

* * * Q. Do you know whether the I. G. Company in Germany bought the Lefort patent rights for Germany? A. I don't know.

Q. Were you ever informed that that was a fact? A. I don't quite remember. We were informed of such things but they were often incorrect as information.

Q. Were you informed that the I. G. Company was negotiating to acquire the German rights? A. I don't quite remember that with certainty.

Q. Would you remember that if it did appear from some of the records which you had just referred to? A. Oh, yes, if they are in the records.

Q. But you don't remember without looking at the records, is that what you mean? Now, referring to the experiments conducted by the Shell Development Company, I presume that is an experimental company? A. Yes, in this country.

Q. And that work was done in August of 1933? A. Yes, sir.

Q. The only work done by the Shell Development Company in this country to test the Lefort process was in that month of August, 1933? A. Yes.

Q. And that is the one that is summarized in this report marked Exhibit—what is the number, is it here? Is it the one I hand you?

Mr. Edmonds: Identify it for the moment as report No. 1759.

Mr. Edmonds: I think that no copy of the—what is your Exhibit 54?

The Clerk: That was a monthly progress report of work done in August, 1933.

Mr. Edmonds: Yes, the marking of the copy of Exhibit 54 was deferred because no photostatic copy was available at the time. That copy is now available, and

is being marked "Defendant's Exhibit 54," with the agreement that that copy may be used in lieu of the original.

(Monthly progress report on work done in August, 1933, by chemists working with Dr. Groll, marked "Defendant's Exhibit No. 54.")

Q. (By Mr. Watson) Mr. Pyzel, was the decision of the American Shell Company not to exercise its option to buy the Lefort patent rights in this country, so far as that decision was based upon experimental test work conducted in this country, based upon that experimental test work in August, 1933? A. Partly.

Q. What other experimental work in this country? A. No other experimental work in this country.

Q. So that, answering my question, so far as it was based upon work done in this country, that work was exclusively work done in Emeryville, in August, 1933? A. Yes, sir.

Q. And that work was reported to you by Dr. Groll? A. Dr. Groll, Dr. Williams, in the laboratory.

Q. Well, I show you Sheet 2 of Exhibit 54, which is stated to be the only one on the subject. A. But you asked for the report. The report includes that.

Q. So that the only written report was that signed by Dr. Groll? A. Yes, sir.

Q. Now, on your familiarity with catalytic processes, did you yourself direct or supervise this work done at Emeryville in August, '33? A. No, I did not.

Q. Did you see it done? A. I don't remember.

Q. Do you know what it consisted of? A. I read the reports.

Q. Well, answer me, what did the work consist of? A. I tried to find out whether——

Q. That is the object of the work. I mean what was the procedure, what materials were used? A. Ethylene, air, oxygen, steam, various kinds of catalysts.

Q. Well, now, was silver used? A. Certainly.

Q. Silver by itself? A. Certainly, silver by itself was used.

Q. How was that silver made? A. In different ways.

Q. How was it prepared as a catalyst? A. It was prepared by various methods.

Q. Well, name them. A. Well, I will have to go back to the records, because I could not remember that far back.

Q. I am asking you, do you know? A. No, I don't remember everything that happened seven years ago in the laboratory.

Q. Well, did you know it then? A. It was a very large laboratory; and it is impossible for any man to remember everything in detail, what happened.

Q. Did you yourself ever try to make a silver catalyst? A. No.

Q. To conduct this process? A. No, sir.

Q. If you were proceeding to do so, as of that date, in the first place, would you take silver? A. If I know that process that I want to check is using a silver catalyst, of course, I would start with silver.

Q. All right. If you know that the process you are wanting to check says that you will use silver on a support or not, you would try it on a support and not on a support, would you not? A. That I don't know. I probably would.

Q. If you tried it on a support or carrier, you would pick out an inert carrier wouldn't you? A. Not necessarily.

Q. Why not? A. Because it is very difficult to say whether a support is inert or not.

Q. Isn't it a simple matter to test it? A. Not as simple as you think it is.

Q. Well, can't you pass ethylene and air mixture over it? A. Oh, yes.

Q. At the temperatures involved? A. I can take one support and another support, both supposed to be inert, and get completely different results.

Q. Do you mean to say that it is difficult to find out whether a support material is inert when ethylene or air, or ethylene oxide is passed over it, at a temperature of between 150 or 400 degrees? A. Yes, it is difficult to determine those things.

Q. You mean so difficult that you have got to try it? A. Well, even so; even if you try it, it is still difficult. It is a most difficult subject that we are talking about.

Q. If you are going to test silver as a catalyst, would you not try to use a support so that when you got your silver on it you would know you were testing the silver and not the support? A. That would be the object of the support, because the support might make a big difference on the behavior of the silver as a catalyst.

Q. Assuming you are testing a process where you are told the silver is a catalyst, not the support is the catalyst, but the silver is the catalyst, then, would you not pick out a support that was inert so that you would know when you put the silver on it you were testing the silver and not the support? A. It is not that simple. Silver can be in all kinds of forms, and the character of the support on which the silver is precipitated or carried or whatever it is, can have an enormous influence on the silver as the catalyst.

Q. I understand you to say it is difficult. Do you mean to suggest that it would be nonsense to try to use an inert support when you are attempting to test the behavior of silver as a catalyst? A. Oh, certainly not. I did not say that. The only thing I said, it is very difficult to know whether the support is really inert or not.

Q. Yes, but it would be obviously desirable to use an inert support, since you are going to test the silver? A. We are going to test the silver on a support or not on a support, and we tried to find out what is the result of that. It is very difficult. If you talk about silver as a catalyst that helps very little; it depends on exactly the shape in which that catalyst is, on what it does, and you have to regulate the shape, and we don't know too much about it. It is exactly how that catalyst is made that is of importance, and that's what we try to find

out. If you say silver is the catalyst you have said nothing, but if you want to have certain results you have to define exactly how to make it because that silver in another form may give you completely different results.

Q. Is that a peculiarity of the Lefort process or is that true of all catalytical processes? A. It is very dangerous in all catalytical processes to make conclusions before you try them.

Q. So that you mean to indicate there is nothing peculiar about this Lefort process, you are making a general comment applicable to all catalytical processes? A. Yes, sir.

Q. So that you think any patent on a catalytic process is totally insufficient in disclosure unless it tells you how to prepare a catalyst in detail? A. It has to give you at least some indications of how to prepare it.

Q. The use of the term "silver" is not enough, in your opinion? A. No.

Q. How about "silver in finely divided form"? A. No.

Q. When you are told to use silver, the skill in the art would be sufficient, would it not, to attempt to use this silver in an active surface form? A. It may be active for one process and inactive with another process, or it may be inactive in the wrong direction. A silver catalyst has been used for the oxidation of ethylene oxide to produce formaldehyde. That's not what you want.

Q. You are expressing a conclusion and I am asking for facts. Was it not well known in the art how to prepare an active surface silver catalyst in 1933? A. Not in this general form, no. It all depends on what type process you want. The surface may be active for one process and may be inactive for another process.

Q. Yes. Did you study the literature or do you know whether your laboratory workers studied the literature in 1933 on the preparation of silver catalysts? A. I expect they did.

Q. I am asking you whether you know it? A. No.

Q. It would be a normal, sensible thing to do, wouldn't it, study the literature? A. I should think it would.

Q. And if the literature indicated suitable inert carriers it would be naturally normal to select one, wouldn't it? * * * [407-417].

* * * A. Yes, sir, it would be, I would say, very remarkable to not try silver on an inert carrier, if you know it is inert.

Q. And the carrier should possess certain mechanical characteristics, isn't that true? A. It may be.

Q. Well, it would be obviously desirable, would it not, to select a carrier of some mechanical strength? You wouldn't want one that crumbled? A. No.

Q. You would want it to have some mechanical strength? A. Yes.

Q. And you would want it to have some kind of surface so that the silver would adhere to it? A. Yes.

Q. And it would obviously be desirable to use it in a form so that when you passed gases through it it would not impede the gas flow, isn't that true? A. You mean it should be granulated?

Q. Preferably. You wouldn't want to use dust? A. No.

Q. And you would want it in such form that the gas would not tend to channel through? A. Yes, sir.

Q. Do I understand you to say that silver has been used in the oxidation of ethylene oxide to formaldehyde? A. As far as I know, yes.

Q. Did you ever do that? A. No.

Q. Did you ever see it done? A. No. It is the subject of a patent.

Q. All right, what patent? A. I don't know.

Q. You don't know what date? A. No, I don't remember the numbers and dates of all the patents I have seen.

Q. Well, having turned to the literature, we will assume in 1933, and having followed the obvious common

sense of selecting an inert carrier which has some mechanical strength and was granular and had a surface to which the silver would adhere, do you know whether the literature taught as one suitable method of depositing silver on such a support, the use of silver nitrate precipitated to silver oxide and reduced, say, at 200 degrees Centigrade with some hydrogen? A. Certainly. It is one method of getting silver precipitated on some carrier.

Q. Do you know whether your experimenters in Emeryville in August, 1933, ever followed that procedure? A. I don't know. I don't remember all these figures, all of these experiments.

Q. What was the price of the option the Shell Company got in the United States? A. I think it was a million and a half francs, but I am not quite sure about it. I would have to look that up.

Q. They paid that for the option? A. No—oh, excuse me—I don't think we paid anything for the option. It was the option to take it, to buy or to use it for a million and a half francs, plus the royalty.

Q. Thirty per cent royalty? A. No.

Q. As far as you know it may have been a 30 per cent royalty? A. No, I don't know. I will have to look at those figures * * * [418-421].

* * * The Witness: Here is a letter from our friends in The Hague to the French company in which they say, in the translation, "Two million francs and a royalty of one franc per kilogram, which you ask we feel bound to tell you we are unable to take into consideration any payment of such magnitude."

Q. And what's the date of that? * * * A. 5th of July.

Mr. Watson: That's all right.

The Witness: Here is a letter from our friends in The Hague to the French people.

Q. And that refers to the sale of the American rights? A. Yes, sir.

Mr. Edmonds: You are also referring to this cablegram of August 29, 1933?

The Witness: Yes, this refers to that date. Here I suggest a—

"Further study of process from technical, economical and patent viewpoint before making recommendation for agreement binding us to definite royalty and cash payments. Consider anyhow royalty far too high and cash payment exorbitant, but can only make definite counter proposals after complete study as mentioned above."

Mr. Edmonds: Have you got the translation of the letter of July 5? The witness read from the paragraph at the bottom of page 1, Exhibit 49.

By Mr. Watson:

Q. It appears from Exhibit 49, then, that you rejected the terms offered for the American rights even before you conducted tests, is that correct? Exhibit 49 was the letter written by somebody from The Hague, in July, July 5, 1933 (exhibiting to the witness)? A. Yes, that was after our friends in The Hague rejected, and we rejected in the cable.

Q. Yes, but at that time no tests on the process had been made in the United States by you? A. Not at that time.

Q. Do you consider the Lefort process, if operative, to be very simple and of great potential commercial value? A. Oh, yes.

Q. And do you consider that from the chemical viewpoint the Lefort process, if it produced ethylene oxide by passing ethylene and air over silver at a temperature between 150 and 400 degrees was a radically new process industrially? A. I think as far as I know, yes.

Q. Now, what one of the Shell companies has gone into the chemicals business? A. What is that?

Q. What one of the Shell companies has gone into the chemicals business? A. The Shell Chemicals Company.

Q. When did it become active in that line, in this country? A. Oh, 1929, 1930.

Q. Since then it has been expanding its line of chemicals? A. Yes, sir.

Q. And competing with other chemical companies in this country? A. Yes, sir.

Q. Looking for new lines of products and processes? A. Yes, sir.

Q. A moment ago I asked you whether it would have been normal or obvious to a skilled chemist in 1933 to consult the literature and find how to deposit silver from silver nitrate as silver oxide, reduce to silver, on an inert carrier. I understood you to say that you do not recall whether your experimenters in Emeryville proceeded in that fashion; is that right? A. That is right.

Q. Do you know now whether if they had proceeded in that fashion they would have conducted the Lefort process, and indeed have obtained ethylene oxide formation? A. Will you repeat that question, please?

Q. Well, it is a long question; I do not want to repeat it if I can avoid it. But if they had selected an inert carrier and deposited a coating of silver on it, by starting with silver nitrate, and precipitated the silver oxide by sodium hydroxide, washing, drying, and so forth, to get the silver oxide on the supporting material, then reduced that at, say, 200 degrees, or thereabouts, Centigrade, with some hydrogen, and that then they had used that simple catalyst in the Lefort process, that is, passed over it a mixture of ethylene and air, at a temperature of 150 to 400 degrees, would they have obtained ethylene oxide? A. I do not know.

* * * [422-427].

TESTIMONY OF HENRY W. DE JONG.

Thereupon—

HENRY W. DE JONG, a witness of lawful age, produced on behalf of the defendant, having been first duly sworn, was examined and testified as follows:

Direct Examination.

By Mr. Barrows:

Q. What is your full name? A. Henry William De Jong.

Q. Mr. De Jong, where do you reside? A. Berkeley, California.

Q. Where are you employed? A. Shell Development, Emeryville.

Q. In what position? A. As a chemist.

Q. And were you so employed in the year 1933? A. I was employed in Emeryville but not as a chemist at the time.

Q. What was your position at that time? A. I was then a laboratory assistant.

Q. Under whom were you working? A. Dr. Groll.

Q. You heard Mr. Pyzel refer to the tests that were carried on in Emeryville in August, 1933? A. Yes, I did.

Q. What did you have to do with those tests? A. Well, I carried them out under the direction of Dr. Groll.

Q. You were first assistant in the laboratory in carrying out the tests? A. Yes.

Q. What papers did you have before you at the time you began the tests, if you recall? A. I had a copy of the Langedijk report No. 5205.

Q. Is this the identical paper that you had before you (exhibiting to the witness)? A. Well, it is the identical paper or a copy of it. There are no identifying marks on it.

Q. Do you recognize the papers that have been put in evidence as Defendant's Exhibits 46 and 47 as also identical papers to the paper you have before you? A. Yes, sir.

Q. What other papers do you recall having before you at that time? A. I had a copy of the French patent.

Q. And can you identify that French patent (exhibiting paper to witness)? A. Well, this is the one, it was either this or one very similar to it.

Q. What is the number of this? A. 739562.

Q. Do you recall any other papers you had before you at that time? A Dr. Groll had several other papers

with him, but exactly what they were I couldn't say. They were other patents, but——

Q. Before you started on these experiments what did you do in preparation for them? A. Well, we talked it over with Dr. Groll as to what lines we were to follow, the catalysts we were to use, and took the copy of the 5205, Dr. Langedijk's report, and looked at the method of analysis and method of operation, and also the type of apparatus used.

Q. And then did you construct a special apparatus for these experiments? A. We constructed an apparatus in accordance with the flow sheet given in 5205.

Q. That is, an apparatus similar to the apparatus which formed a copy of this report 5205, Exhibit 46? A. Yes, sir.

Q. Now, was the apparatus identical with that, or how close to it did it come? A. We used three furnaces instead of two, in order to get the right length of the catalytic space.

Q. Well, since that time have you prepared a drawing of this apparatus, recently, showing that apparatus as you recall its construction? A. Yes, sir.

Q. And is that the drawing (exhibiting to witness)? A. Yes.

Mr. Barrows: We offer this in evidence.

(Drawing of apparatus used in experimenting at Emeryville marked, "Defendant's Exhibit 69.")

Q. Now, will you describe briefly just what the apparatus was and how the process was carried out in it? A. The apparatus consisted of a tube containing three furnaces, and it had an inlet at the head of the tube to introduce the water first and a side inlet where the gas was introduced, and from the top it went into a condenser, such as a flask, to collect the materials condensed, and from there on the remaining gases passed through a series of washing bottles containing water in which they were kept in a bath where any ethylene oxide that might be formed would be absorbed, and from there the gases were led through a second trap which was contained in

a cooling mixture of alcohol and CO_2 to trap any further ethylene oxide that might be present, and as a third check they passed from there on to a bottle containing magnesium chloride which would precipitate any ethylene oxide present which was not trapped in the previous traps.

Q. Where was the catalyst located in this apparatus? A. The catalyst was located right inside of the tube for the length of these three furnaces.

Q. And how did you maintain the temperature in the tube? A. We had a thermocouple right in the center of the tube which might be moved back and forth according to the exact location of the highest temperatures.

Q. Where did you get the proportions of the gases you used in these experiments? A. The proportions were used in accordance with the report of Dr. Langedijk 5205.

Q. And you studied that report and drawing to follow it out as closely as you could in accordance with the procedure thereof? A. Yes, sir.

Q. How about the analytical tests made of the product, did you make them or were they made by somebody else? A. The analytical tests of the product were made by me, whereas the gas tests were made by the analytical laboratory.

Q. What method did you follow in the making of the test you made? A. We used a method outlined in the report 5205.

Q. And did you make records of the experiments that you made at that time? A. Yes, sir, all the records were kept in a notebook.

Q. Is this the notebook in which you made these records? A. Yes.

Q. On what pages are these experiments recorded? A. The experiments start on page 77 of the notebook and end on page 94.

Q. Between what dates were these experiments carried out? A. The dates are August 3rd, 1933 to August 31, 1933.

Q. Are all of these pages you have identified in your handwriting? A. Yes, sir.

Q. Are certain of the headings or notes in the handwriting of someone else? A. There are two headings, in the first two experiments and two notes in the first two experiments which were made by someone else.

Q. Who were they made by? A. By Mr. Hearne of our laboratory.

Q. He was working in your laboratory at that time? A. Yes, with us.

Q. But the actual carrying out of the experiments you say, and the other records were made by you? A. Yes, sir.

Q. The remainder of this notebook contains nothing relating to the production of ethylene oxide for this process? A. Nothing other.

Q. And it does contain reference to many other matters? A. Yes.

Mr. Barrows: We offer in evidence photostat copies of the title page and pages 77 to 94 of the notebook produced by the witness.

(Title page and pages 77 to 94 of notebook produced by witness De Jong marked "Defendant's Exhibit 70.")

Q. Now, will you turn to the first experiment, Mr. De Jong, and state what catalyst you used in that experiment? A. In the first experiment we used a catalyst containing silver arsenic alloy.

Q. How did you come to use that particular catalyst in the first experiment? A. We had that catalyst on hand. It had been previously used for other furnace runs.

Q. And was it a satisfactory catalyst in the other processes in which it was used? A. Yes, it was with the other processes.

Q. What results did you get when you used this catalyst in this process? A. In this process we got no ethylene oxide formed.

The Court: You say you got no ethylene oxide?

The Witness: Not with that catalyst, no, sir.

By Mr. Barrows:

Q. In carrying out this and the other experiments you say you followed the same general procedure, on gas composition as in the report which was furnished you? A. Just as closely as we possibly could.

Q. Now, in the next experiment, what page is that on in the notebook? A. That is on page 79.

Q. What catalyst did you use in the second experiment? A. Silver turnings.

Q. Was that a catalyst which had previously been used in other processes? A. Yes, we had used that before, too.

Q. And was that a satisfactory silver catalyst in the other process? A. Yes, sir.

Q. What results did you get with this experiment? A. We also got negative results on this experiment in the formation of ethylene oxide.

Q. By negative results, you mean you obtained no ethylene oxide? A. Yes, sir.

Q. What was the next experiment and what catalyst did you use? A. The next experiment was number three on page 83, where we used what we call an activated silver catalyst.

Q. Was that catalyst and its preparation described in the notebook? A. It is described on page 81 of the notebook.

Q. Was that a catalyst which you had previously used in other processes? A. It was a catalyst which Doctor Groll had previously used but I had not personally used before.

Q. Were all of these catalysts suggested by Doctor Groll? A. Yes.

Q. And you merely used the catalyst he furnished you or told you to use? A. Yes, sir.

Q. Now, the method of preparing this activated silver catalyst on page 81, where did you get the directions for that? A. Those were given me by Doctor Groll.

Q. What results did you get with this catalyst? A. With this catalyst we reported some results in traces of ethylene oxide and no results in other places.

Q. Will you explain what you mean by traces, what you regard as a trace? A. In preparing the sample we use a certain amount of hydrochloric acid which is heated with the material collected and after heating, the material is cooled to determine the amount of hydrochloric acid used, which should correspond in titration to the material. If we find a small discrepancy, we put down traces of ethylene oxide formed, although there was no certainty that there was any certain amount formed.

Q. Would what you regard as a trace be any definite amount that you could give any measure to? A. It would be worthless.

Q. What is the next catalyst you tried? A. Run No. 4 on page 85, we tried a silver copper catalyst.

Q. Is the method of preparation of that catalyst given? A. It is given on page 81.

Q. Was that a catalyst which you had used before or which had been used as far as you know? A. It was new to me but Doctor Groll gave me directions for the preparation.

Q. What results did you obtain with that catalyst? A. In this run we again recorded a trace of ethylene oxide formed at temperatures around 375 degrees.

Q. And the significance of the trace is what you just explained? A. Yes, sir.

Q. What catalyst did you try next? A. Run No. 5, page 87, we tried silver copper catalyst again.

Q. The same catalyst or a different catalyst? A. The same catalyst but this time we reduced it with hydrogen previous to running the ethylene air mixture through.

Q. What results did you obtain in this test? A. In this test we reported a trace of ethylene oxide formed.

Q. What catalyst did you try next? A. Run No. 6, page 89 we tried a catalyst which is quite complicated but the preparation is given on page 88, a catalyst containing a series of elements which we took from the French patent and includes silver, lead, nickel, tin and bismuth on pumice as a carrier.

Q. What results did you obtain with that test? A. In that test we again obtained negative results, no ethylene oxide formed.

Q. What did you do next? A. Run No. 7, page 91, we reported running a test except this time we reduced the catalyst with hydrogen passing through.

Q. What results did you obtain in that experiment? A. We obtained a trace of ethylene oxide again.

Q. Then what catalyst did you use? A. On page 8, run number eight I mean, page 93, we used a catalyst which is again complex and its preparation is given on page 92, containing various elements on pumice.

Q. Do you recall how you came to prepare that particular catalyst? A. The directions were given me by Dr. Groll.

Q. What results did you obtain with that catalyst? A. No ethylene oxide was formed with that catalyst.

Q. What was the next catalyst you used? A. Run nine, page 94, we used a catalyst known as Hopcalite, which is an oxidation catalyst.

Q. Was that prepared or did you have it on hand? A. That is prepared commercially, used in gas masks.

Q. What results did you obtain on that? A. In that catalyst we had great difficulties keeping the temperature down because we got glowing in the catalyst and the result was the formation of CO_2.

Q. Did you assist Doctor Groll in writing up the report of these tests? A. Yes, sir.

Q. Is this the report? If so, will you state in whose handwriting it is and what you had to do with it? A. It is a report in Doctor Groll's handwriting and it contains a section on catalysts which is in my handwriting.

Q. Which pages are in your handwriting and which are in Doctor Groll's? A. Page one is in Doctor Groll's handwriting and pages two and three are in my handwriting and pages four and five in Doctor Groll's handwriting.

Mr. Barrows: I offer a photostatic copy of this report in evidence.

(Photostatic copy of report of Doctor Groll and Mr. De Jong marked Defendant's Exhibit 71.)

Q. I show you, Mr. De Jong, Defendant's Exhibit 65, which is pages 42, 44, 45 and 46 of the Shell Development Company report for the period ending December 31, 1933 and ask you if you had anything to do with the preparation of that report and particularly the very beginning on page 44, paragraph No. 3? A. Yes, the report was written by Doctor Groll and given to me for correction or editing prior to publication.

Q. And is that report one which you saw shortly after it was completed? A. Yes, sir.

The Court: What was that you just referred to, is that this one?

Mr. Barrows: No.

By Mr. Barrows:

Q. One more question, Mr. De Jong. In these experiments which you carried out, how much water did you use expressed in the approximate percentage composition of the total mixture of ethylene, air and steam? A. The steam amounted to approximately 65% to 75% of the whole mixture.

Q. That is, it would be some two or three times as much as the whole volume of air and ethylene mixture used? A. Yes, sir, that is right.

Q. How did that compare with the proportion of steam used in the report which you say described the apparatus and the procedure that you followed? A. It is nearly identical. In the report, I believe 70 to 75 per cent.

Mr. Barrows: That is all.

I have other photostatic copies of these original exhibits; and I understand that is agreeable to counsel for the plaintiff and the court.

Mr. Watson: We will never object on the mere ground that they are photostatic copies.

CROSS EXAMINATION.

By Mr. Watson:

Q. How old are you? A. Pardon me.

Q. How old are you? A. Thirty.

Q. So when you undertook this work you were 23? A. Yes, sir.

Q. Now, what was your education? A. I was one year at the University.

Q. What university? A. The University of California, Berkeley.

Q. What course? A. Chemistry.

Q. You are here under subpoena? A. No, sir.

Q. Who told you to come? A. Our patent department in San Francisco.

Q. Who is paying your expenses? A. I have no idea, sir.

Q. Are you getting anything beyond your expenses? A. No, sir.

Q. Now, referring to your second test, when you used silver turnings, in what other process had you used those? A. We had used them some in our ketene experiments.

Q. In what other process did you use those silver turnings? Describe the process, please? A. Well, it is a process of passing—well, the only thing is, I don't know that I am allowed to give the process.

Mr. Watson: Well, I won't pursue the subject, if the Court please; but I submit that that certainly destroys the weight of the witness's testimony.

Q. (By Mr. Watson) How are turnings made?

Mr. Edmonds: Just a minute. We would like to have this witness explain everything of the sort to counsel that he wants to know. At the same time, he feels under some obligation to his Company not to tell things that are within the company's secret procedure, unless it is needed here.

And on this particular thing I think I can tell him that the company does not object to his answering on this; and I would like to advise him that he need feel no restraint on this point, so far as the company is concerned.

The Court: Well, what I would like to know,—that might simplify things a good deal,—is whether you used silver in the way that it is used in that model that the plaintiff had explained very fully, through Prof. Stevenson.

The Witness: Yes, sir, we have used it for the dehydration of alcohols to ketones.

The Court: You did what?

The Witness: Used it for dehydration of alcohols to ketones, passing the alcohol over the catalyst, and removing the product, in the same manner as we did in this particular experiment.

The Court: You know what I am referring to, that model back of you. Did you prepare the catalyst in a form such as that?

Mr. Edmonds: The witness was not here on Thursday and Friday of last week, when that was under discussion.

The Court: Well, he can look at it now.

Q. (By Mr. Watson) Walk over and look at it. A. I can see it from here. Do you mean that particular form of catalyst?

The Court: Well, that has been explained by the plaintiff's witness as a common form of silver catalyst that could normally be used according to the teaching of this patent.

Now, my question is—I do not know whether you accept that as a fact—but without asking you to accept

it or not, I want to know this, did you prepare something akin to that?

The Witness: May I take a look at it?

The Court: Yes.

(Model referred to examined by witness.)

The Witness (continuing): We prepared something just like that for our later experiments, but not in the first silver turnings experiment.

The Court: Not in those you have just gone over?

The Witness: Oh, yes, sir. In the later ones, where we used a combination of elements on a pumice carrier.

The Court: Well, then do I understand that before you got through making these various catalysts, and giving your report, from which you say your results were unsatisfactory, that you got only very small traces of the desired product, you used, you made up a catalyst like that?

The Witness: Yes, sir.

The Court: You made up a number of others?

The Witness: Yes, sir.

Q. (By Mr. Watson) Do you know how that catalyst was made? A. No, sir.

Q. Then, why do you say you made up one like it? A. Only from a visual point of view.

Q. Only from what? A. From looking at it.

Q. Assuming that that is a deposit of silver on an inert carrier like filtros, in any of those experiments that you testified about, did you make a catalyst of silver alone, on such an inert carrier? A. Does the question specify silver alone?

Q. Yes, sir. A. Not silver alone, no.

Q. I notice in some of your tests you used a mercury treatment? A. Yes, sir.

Q. What was that on? A. That was on silver, silver turnings.

Q. Had you read the literature on the subject of oxidation catalysts— A. I had not.

Q. —at the time you undertook this work? A. I had not, no, sir.

Q. You got your information from Dr. Groll? A. Yes, sir.

Q. Did Dr. Groll tell you that mercury was known as a violent poison for catalysts? A. No, sir.

Q. In your third experiment, I think you referred to activated silver. Was that the silver turnings? A. Yes, sir.

Q. And how was the activation? That was the activation of mercury. Just what did the treatment consist of? A. It consisted of spraying mercury on silver and allowing it to stand for a certain length of time, during which the mercury was driven off by heating.

Q. At what temperature? A. I believe that is in the notebook. (Notebook handed to witness.) 500 degrees under reduced pressure.

Q. 500 degrees Centigrade? A. Yes, sir.

Q. When you used the 500 degree temperature, did you know that in the subsequent use of the silver in your apparatus, where you were passing ethylene and air, you were to employ a temperature much lower than 500 degrees? A. As a starting temperature, yes, sir.

Q. What was the temperature used in your apparatus on the test No. 2 and the test No. 3? A. In test No. 2 we started at 375, and finished at 450 degrees Centigrade.

Q. And test No. 3? A. And test No. 3 we also started at 375 degrees, and finished at 550 degrees Centigrade.

Q. You mean that in test No. 2, where you used the silver turnings, that those turnings were actually physical turnings which had been used in another process? A. Yes, sir.

Q. Not merely silver turnings of the same kind, but some which themselves had been used in this other process? A. No, sir, they were fresh.

Q. That is what I am asking you. Now, how long did that run continue? A. Which run?

Q. Run No. 2. A. Run No. 2 was carried out from 1:40 P. M. to 3:40 P. M., two hours.

Q. What is your last answer, two hours? A. Two hours, yes, sir.

Q. And that showed that you were getting no oxidation? A. It showed that we were getting no ethylene oxide formed, as far as the test was concerned.

Q. Were you getting any oxidation of ethylene? A. No, sir, not according to our gas analysis.

Q. You were getting no carbon dioxide? A. No, sir.

Q. From that you concluded that the silver did not have an active catalytic surface? Correct? That particular batch of silver did not, yes, sir.

Q. In order to give it a more active surface, you then subjected it to the mercury pre-treatment? A. Yes, sir.

Q. Now, could you observe a change in the appearance of the silver turnings after the mercury treatment? Did the surface look different in the case of test No. 3 from the silver turnings in the case of test No. 2? A. If I followed you right, the surface looked more like a gray, a sort of grayish.

Q. And how long did this run continue? A. That run was carried out in two sections: The first part from 10:30 in the morning until 12:01 P. M., and was started again at 2:25 P. M., to 4:08 P. M.

Q. Does the note at the bottom of page 83 mean that in the first two of a total of three gas analyses, you obtained no carbon dioxide? A. Yes, sir.

Q. That means, doesn't it, that the ethylene was not reacting? A. Yes, that is quite possible.

Q. And in the third sample—what time was the third sample taken? A. The third sample was taken just before the run shut down. Probably 4:05, possibly.

Q. And at what temperature? A. A temperature of 550 degrees Centigrade.

Q. And in that case you got the .6 per cent of carbon dioxide? A. Yes, sir.

Q. When you were getting no carbon dioxide, weren't you certain that there was no oxidation of ethylene occurring? A. We did not get an analysis run until possibly a day or so after the run was shut down.

Q. Well, after you got the data on this sheet weren't you certain that in that test you were getting no oxidation of ethylene? A. Well, I would take that to be certain, yes, sir.

Q. You would what? A. In my opinion I was certain.

Q. What depth of catalyst did you employ? A. You mean the length of the tube?

Q. Yes. A. Approximately a metre long.

Q. How much of it filled with catalyst? A. The entire length of the furnace, which was the entire length of the tube, practically.

Q. Was the tube you used such that the catalyst tube was arranged horizontally as shown in your drawing? A. At a slight incline.

Q. How did you fill the catalyst tube? A. We put a small amount of glass wool as a plug at one end and then put the catalyst in and put a small plug at the other end to hold the catalyst in.

Q. Was the tube entirely filled? A. For the distance of the furnace, yes, sir.

Q. You are sure it was not a case where the catalyst was simply along the lower portion of the tube? A. No, sir, because we filled in very slowly and tapped the tube as we were filling it.

Q. And what? A. Tapped the tube.

Q. To what temperature did you heat the apparatus shown at the left end of the tube? A. That was heated to approximately 125 degrees, slightly over the boiling point of water.

Q. What was in that vessel? A. It was an empty vessel, simply an aluminum block.

Q. What did you pour into the vessel? A. Water was led into the vessel and evaporated into the tube.

Q. You mean water was put into that vessel at 125 degrees, water was dropped into it? A. No, we put it in by air pressure, from the graduated cylinder.

Q. At what pressure? A. Possibly one or two pounds pressure.

Q. Two pounds gauge, you mean? A. Yes, sir.

Q. Please explain to me, if you will, just how you put steam or water or whatever it was you used, in the vessel at the left of the catalyst tube? A. A little pressure was kept in this glass graduated cylinder which is merely for the purpose of forming the flow and the flow was controlled at this needle valve here on top, and the needle valve opened to the extent you wished water to go into the evaporator, and from here the steam is passed to the tube.

Q. I still don't understand you. You mean that the graduated cylinder at the left of the drawing was filled with water? A. Yes, sir.

Q. At room temperature? A. Yes, sir.

Q. And you put some pressure on that which forced the water through the line indicating a pipe to drip down into the vessel under which a burner is indicated? A. Yes, sir.

Q. At what rate did you feed the water? A. The water was fed approximately three cubic centimeters per minute.

Q. Where did the ethylene come from? A. Ethylene was fed in from a gas holder where it had been mixed with air previous to the time.

Q. What was the rate of that feeding? A. The rate of feed approximated three cubic feet an hour.

Q. At no time, as I understand you, was there liquid water in the vessel indicated to the left of the catalyst tube? A. No, not as far as we know. I mean the water was flashed right out of the vessel, that was the purpose of it.

Q. Did you analyze your ethylene? A. The mixture of gases at the start, you mean?

Q. I mean, did you analyze your ethylene? A. I don't quite understand your question.

Q. Are you a chemist? A. Yes, sir, but I don't know what ethylene you mean, starting or finishing ethylene?

Q. The ethylene you started with? A. You mean ethylene in the pure state before we blended it in with the air, is that the question?

Q. Did you analyze it at any time? A. Analyzed the mixture after we blended it in the gas holder.

Q. What did your analysis show? A. Well, several gas holders were made up, and No. 3 analysis showed 10½ per cent ethylene and 17.9 per cent oxygen.

Q. Did you analyze it to see whether the ethylene was pure? A. No, sir, the ethylene was bought commercially.

Q. In your ninth run where you used Hopcalite, you stated you got a glow in the catalyst? A. Yes, sir.

Q. That meant a temperature of something over 600 degrees Centigrade? A. I have no idea. We got 275 Centigrade after throwing our rate back somewhat.

Q. You are not familiar with the chart of temperatures by color? A. I have seen it once upon a time, yes, sir.

Q. What is the composition of Hopcalite? A. I have seen it but I can't recall offhand. It is a commercial preparation.

Q. Now, as to these nine experiments in how many of them did you use metal on a carrier? A. In experiments 6, 7 and 8, three experiments.

Q. And that carrier was pumice? A. Yes, sir.

Q. And in none of those did you use only silver? A. No, sir.

Q. Now, when did you enter the employ of the Shell Development Company? A. In 1930.

Q. And how long did you remain as a laboratory assistant there? A. Until 1936, I believe it is

Q. Did you ever try silver gauze as the catalyst for this operation? A. Not for this operation, no, sir.

The Court: What was the answer?

A. No, sir.

The Court: Well, isn't that one of the suggested methods of this French patent? A. I don't recall the text of the French patent.

Mr. Watson: It is, your Honor.

The Court: Let me ask you this: Why didn't you try every method suggested by the French patent?

A. Well, as Dr. Groll states in one of those reports it would lead to an endless combination of these various elements that are suggested for the catalyst.

The Court: Well, I mean more of the major methods that were suggested. They set out several of them here, don't they?

Mr. Watson: I am particularly interested in why he did not try even one of them.

The Court: As I understand it, the first patent—you had both patents before you?

A. Dr. Groll had several of the patents. I can't exactly state which ones he had before him.

The Court: Well, were you given instructions as to how to make the catalyst or were you left free to do that?

A. I was given instructions by Dr. Groll.

By Mr. Watson:

Q. The French patent you had was the second main patent, was it not? No. 739562, I think?

The Court: Well, the one I have here is 41,484.

Mr. Watson: That is one of the patents of addition, your Honor, I think.

The Court: Oh, is it? Yes, No. 739562.

By Mr. Watson:

Q. I think you have stated when you did this work you were not familiar with the literature on the subject of preparing active surface catalysts, is that right? A. Yes, sir.

Q. And you have no idea why Dr. Groll told you to prepare these in the way you did prepare them? A. As mixed catalysts, you mean?

Q. Any of them? A. Well, the mixed catalysts were prepared because we wanted the combination of the very elements that were stated in the French patent.

Q. I am asking you in the way you prepared them? A. The method? No, sir.

Q. Did you find anything in the French patents about treatment with mercury? A. I don't believe there is, no, sir.

Q. Do you know why Dr. Groll excluded from his instructions a request to deposit silver, as silver metal alone, on a support? A. No, sir.

Mr. Watson: That's all.

Mr. Edmonds: That's all.

The Court: Let me ask you one other question: You did not work directly with the patents, you did not have them before you, the French patents?

A. I had this one French patent, 739562 which I read in conjunction with Dr. Groll at the time.

The Court: 739562: And the addition?

A. No, sir, I don't recall that I saw them.

The Court: You did not have the addition?

A. Dr. Groll may have, but I did not personally have them.

The Court: You did not have them to work with?

A. No, sir, I took my instructions entirely from Dr. Groll about the operations.

Mr. Watson: And, of course, you did not have the United States Lefort before you?

A. I believe Dr. Groll had it, yes, sir.

Q. It had not been issued, so you did not have it? A. That was one written in English. I understand he had that.

By the Court:

Q. Have you ever tried to make ethylene oxide with a catalyst following the instructions of the additions to the French patent you referred to or by following the instructions of specifications in the American patent? A. Personally I have had no further work except as mentioned in the book.

The Court: That is all, sir. [429-468].

TESTIMONY OF HUGH STOTT TAYLOR.

Thereupon——

HUGH STOTT TAYLOR, a witness of lawful age, produced on behalf of the defendant, having been first duly sworn according to law, was examined and testified as follows:

Direct Examination.

By Mr. Edmonds:

Q. Doctor Taylor, will you state where you reside and what your present occupation is? A. I reside in Princeton, New Jersey. My present occupation is Professor of Chemistry and Chairman of the Chemistry Department of Princeton University.

Q. At this point, Doctor, I will have to ask you to tell us something about your education and experience and degrees and honors and so forth which would entitle you to testify with respect to catalytic operations. • • • [468-469].

* * * A. I attended Liverpool University from 1906 to 1912. I studied in Stockholm, Sweden and Germany from 1912 to 1914 and at Princeton as an instructor and other positions continuously since 1914 to the present date and since 1927 as Professor. I am the author with Professor E. K. Rideal of a textbook entitled "Catalysis in Theory and Practice," first edition, 1918, second edition, 1924, 1925 or thereabouts. I am a member of the committee on Catalysis and author of several patents in the field of Catalysis and consulting chemist for the DuPont Company for ten years in the field of catalysis and consulting chemist in the field of catalysis for several petroleum companies at the present time.

Q. I think that is probably enough. I take it you have read the original Lefort patent and also the Reissue of that patent and you think you understand the disclosures mentioned in them? A. Yes, sir.

Q. Now, will you tell us whether or not you think these two Lefort patents, the original and the Reissue, disclose the same process or different processes and, if the latter, will you set forth the basis for your views? A. It is my conclusion that the original patent and the Reissue disclosed two entirely different processes. From the language of the original specification, I gather that the original process patented by Lefort consists in the simultaneous action of oxygen and water on ethylene, permissively also in the presence of hydrogen, to produce ethylene oxide. The language of the second, the Reissue patent, differs fundamentaliy from that. As is disclosed, first of all by examination of the original filing for the Reissue in which the process claimed is for the production of ethylene oxide from ethylene and oxygen with water or steam, water vapor, and hydrogen as permissive admixtures with the two, ethylene and oxygen. The language of the first patent indicates clearly what the inventor desired to cover since he specified the types of ethylene that could be considered, ethylene from coke oven gas, ethylene from alcohol, ethylene from carbon and acetylene and if he had been living in this country, he would doubtless have suggested ethylene from the destructive distillation of petroleum. He then specified water and he described

how the water could be introduced into the reaction system. It could be introduced into the reaction system either from a steam line as live steam or it could be injected into the reaction system as water and then having named his ethylene and his water, he then suggests that for the oxygen he can use, you can make use of, for example, an air supply. He then proceeds to describe three different methods of operating this particular process and in each of those it is quite clear the process describes a process for the use of the simultaneous action of water and of air on ethylene because the first process specifies a high pressure unit into which the ethylene and air are introduced possibly under several atmospheres pressures and into which the water is to be injected by means of a pump. Now, if you calculate what pressure of the water vapor will be in equilibrium with water injected by a pump into the system at 200 degrees, it is a simple calculation to show that there will be fifteen atmospheres pressure of steam at least, and if you assume with the specification that the preferable working pressure is fifty atmospheres as it is given in the first column of the specification of the original patent, you will see that that particular thing calls for approximately thirty per cent. of steam in the reaction mixture.

Modus operandi 2 calls for the use of ethylene and air, which already has some water vapor in it—water vapor—and then in addition the claim for hydrogen, which specifies a minimum of 5% of hydrogen introduced into the system, or 5% of hydrogen—I am not quite sure whether he says a minimum of five—5% of hydrogen introduced into the system. That seems to say without the water vapor in the air, without the water vapor that is especially introduced, there is at least 5% of water vapor produced by the known interaction of the hydrogen and air introduced in the presence of a silver catalyst, and the temperatures raised.

Finally, modus operandi 3 calls for a reaction in a liquid water system, whereby ethylene is made to dissolve in the water, and the reaction is conducted in contact with the silver colloid, in contact with a silver colloid in the water system.

Now, if one goes over that particular patent, in the light of what had been previously disclosed in the literature—for example, the disclosure of Willstatter and Bommer, that the oxidation of ethylene conducted in the presence of silver, copper and osmium catalysts fails because of the oxidation of the ethylene to carbon dioxide and water—in the case of osmium, from 120 degrees upwards—in the case of copper, at somewhat higher temperatures—leading Willstatter and Bommer to the conclusion that these catalytic agencies are worthless for the oxidation process in general; knowing also, for example, that Reyerson had already disclosed that a silver catalyst spread on an inert support, such as silica gel, converted ethylene completely to carbon dioxide and water; in the light of those prior disclosures one is tempted to say that the real disclosure in the first patent is that by the utilization of water in addition to other reactants, ethylene and oxygen, one can, as I think it actually says in the language of the patent specification, one can so far suppress the oxidation to carbon dioxide and water that one can get yields of ethylene oxide.

Now, that point of view is thoroughly confirmed if one reads the original French Patent specification of March, 1931—March 1931, I think—and the several additions which are made to that patent between the time of the original convention date and its application in this country under the original convention date.

The first of the French patents has a very high degree of improbability, from the standpoint of a catalytic expert, because it specifies materials which the catalytic expert would normally suggest as unlikely, with a degree of unlikeliness amounting to almost a certainty—unlikely that they would act as oxidation catalysts. And it is only in the subsequent additions that silver is introduced into the picture. But all through the original patent, which calls for the simultaneous action of water and steam in the presence of a contact agency, the first one improbable, silver and various others introduced later, some very improbable ones also introduced later, one gets there a whole sequence of experiments regarding the progress of the French company during a period

of one year, which is finally translated into an American application, the original application.

If one goes carefully through that one finds on several occasions passages which confirm one's view that what it was intended to do was to patent the simultaneous action of water and air on ethylene.

The Witness (continuing): The original patent of the 27th of March, 1931, application date, specifies arsenic, antimony, their mixtures, and the mixtures of these latter. That is the application which I think, because of the nature of the catalysts suggested, gives one the impression that it is what is generally termed a paper patent, or, if I might express it otherwise, betrays a high degree of improbability that the process is a real one.

The first addition is to indicate new catalysts, and the catalysts are then just any mixture that can be taken, of antimony, lead, nickel, tin, zinc, arsenic. There again one has an introduction of materials that are highly improbable. Nickel especially is a very improbable oxidation catalyst introduced into the specification at that particular point, the first addition, No. 41255, date 4th of July, 1931.

In the second addition, of an application date 10th of September, 1931, one has a specific indication of the necessity of using water.

We read there, "The purpose of the present addition is to specify that the formation of glycol obtained by the oxidation of ethylene by atmospheric oxygen, in the presence of water, is necessarily derived from the saponification of the ethylene oxide obtained in the first stage by direct oxidation of the ethylene. The mechanism indicated in the principal patent and the first addition relative thereto, accordingly leads first to the production of ethylene oxide, which by a direct saponification gives the glycol. But tests made by the applicant show that the catalysts indicated do not enable one to obtain ethylene oxide by the oxidation of ethylene if the gases are dry. The presence of water is necessary for the production of ethylene oxide, even apart from any attempt to bring about saponification."

That, it seems to me, clearly indicates the intention of the authors to cover the simultaneous action of water and oxygen for the production of ethylene oxide.

The next addition, filed September 25, 1931, specifies the use of hydrogen, 5 per cent.

The fourth addition calls for various methods of activating silver by introducing small quantities of gold, copper, and iron.

Please notice, however, that the principal French patent has for its object a process of obtaining ethylene glycol, which consists principally in subjecting the ethylene to the simultaneous action of the atmospheric oxygen and water, in the presence of catalysts under atmospheric or superatmospheric pressure.

So that as far as all of the first four additions are concerned, the process is for the oxidation of ethylene in the presence of water.

That was followed by a French patent, taken out on the 3rd of October, 1931, number 739562, which bears great similarity to the initial specification, because it is noted that you obtain ethylene oxide here, whereas the original French patents had called for ethylene glycol. And, therefore, one, has in 739562, a patent which is quite similar, though it differs in minor details from the original American specification, and is characterized principally in that ethylene is subjected to the simultaneous action of atmospheric oxygen and water in the presence of a catalyst, and hydrogen.

That, I think, clearly reveals the amount of information—there are one or two additions to that: There is that first addition, the 19th of December, 1931. There is a second addition, which is much later than the things we are considering, because the second addition was asked for in June, 1934. So that 739562 and its additions were available to the authorities when they filed the application for what ultimately was issued as 1998878.

This particular patent appeared in a reissue form on May 18, 1937, the reissue having been applied for September 25, 1936.

The Witness: The original specification says, "This invention has for object a process for the production of ethylene oxide, which mainly consists in subjecting ethylene to the simultaneous action of the oxygen of the air and of water, in presence of a catalyzer, and if need be of hydrogen." It is interesting to see what the reissue calls for. The wording is very similar. "This invention has for its object a process for the production of ethylene oxide, which consists essentially in subjecting ethylene to the action of oxygen of the air, in the presence of suitable catalysts, at temperatures between about 150 and 400 degrees Centigrade. If desired, water, or hydrogen, or both may be introduced for the purposes of facilitating or accelerating the reaction, as more fully hereinafter described.

What the experts have to decide is whether on April 23, 1935, when No. 1,998,878 was published, this particular patent contemplated the reaction of ethylene and oxygen permissively in the presence or absence of water.

The Court: Now, let me see, just to interrupt you for a moment, if I understand you: you say that when that patent, the original one, 1998878 was applied for and issued it had as its obvious basis the French patent which you say made water an indispensable element? A. Yes, the original French patent 729952 with its several additions, and they had available to them also No. 739562 and one addition.

The Court: I just wanted to see if I understood you. Now, you go on from there.

Mr. Watson: I might say that your Honor and the witness are not in accord on that.

Mr. Edmonds: I think they are.

Mr. Watson: I got the impression the witness did not understand your Honor's question.

The Court: Well, I will repeat it. I followed the evolution as Professor Taylor has given it of the French patent and the gist of what he stated is that he considers that evolution clearly indicates that water was made a sine qua non of the whole business. A. Yes, sir.

The Court: And then you say that the original American patent, the United States patent, was based on that?
A. Yes.

The Court: That is, the French issue culminated in the two French patents. I just wanted to get that straight.

Now, go ahead, proceed from there and explain what happened after that in the United States Patent Office.

The Witness: An expert invited some time after April 23, 1935, to examine whether this process claimed the oxidation of ethylene by air and permissively with water would certainly examine all the available material that had been published in this field up to that time; and in doing that I came across another French patent for the oxidation of ethylene with air in the absence of water, and I found that that French patent was claimed by the same society that took out these patents, and they claimed that particular French patent as a new invention.

The Court: Now, you are referring to a patent that has not heretofore been referred to in this case?

A. Yes, sir. * * * [474-488].

* * * The Witness: This late French patent by the Societe Francaise de Catalyse Generalisee is No. 771650. It was filed on July 10, 1933, and granted July 30, 1934, before the original American patent was issued. And the first paragraph shows the striking variance from the two preceding patents. It says: "The present invention relates to the preparation of ethylene oxide by the direct oxidation of ethylene in contact with pure oxygen or air."

Now, I called your attention to the original specification for the reissue. I now wish to call your attention to the final specification for the reissue.

The Court: As it appears in the reissue patent?

A. Yes. It essentially consists in causing ethylene to combine directly with molecular oxygen: "The present invention of date 1933 relates to the preparation of ethylene oxide by the direct oxidation of ethylene in contact with pure oxygen or air," and then it goes on to explain why this is a valuable discovery.

"The reaction during oxidation requires special precautions against explosion hazards. In connection with the industrial oxidation of ethylene it was suggested as early as 1904 that water vapor be introduced into the reaction. The explosion hazards are thus caused to disappear but the oxidation products have always been aldehydes.

Now, the third paragraph——

The Court: I don't know as I understand that.

The Witness: Well, they are just saying that previously water vapor has been introduced and that previous literature prior to the literature discussed in the next paragraph indicates that you got aldehydes, formaldehyde, in all probability, in addition to the ethylene.

The Court: You mean water vapor was introduced to lower the hazards but in lowering the hazards you got poorer results, is that what you mean? A. Yes, they say you got aldehydes and that is a different result from the patent in consideration.

The Court: Well, would another way of putting it be this: that you reduced the hazard but you did not get as good results as you desired.

A. Did not get the desired results.

Mr. Watson: You got entirely different results.

The Witness: Yes, you got aldehydes. According to the statement of this paragraph you got aldehydes.

The Court: Well, then, if you take that literally, that second sentence is tantamount to saying that the previous inventions were no good?

Mr. Edmonds: This paragraph is about 1904, the disclosures of 1904.

Mr. Watson: That paragraph points out, I think, if the Court please, that the same reference in 1904 had nothing to do with this subject.

The Court: Well, if you read the last sentence of the second paragraph as being modified by the words, "as early as 1904," that is true, but it does not read that

way to me: "Explosion hazards are thus caused to disappear," "are thus caused," reading as of 1904.

Q. But the oxidation products have always been aldehydes? A. Yes, the claim here is that the previous work differentiates itself from that of the preceding French patent claims by this company in that ethylene oxide was not the product but aldehydes. The statement of their invention is in the third paragraph.

By the Court:

Q. I don't think I have made myself clear. If you take the last sentence of the second paragraph of this newly discovered French patent 771650, it would seem to say that this inventor has found out that it is a bad thing to use water because although it lowers the hazard of explosion, you did not get ethylene oxide. That is what the sentence says. A. But he qualifies it in the next paragraph.

Q. I haven't come to that. That is what he says, isn't it? A. Yes, and that, of course, is prior art, but I am not discussing prior art now.

Q. Now, but if you stopped there it would be tantamount to saying that he thought he had something which was really effective and that the prior French patents were really paper patents because they used water and did not produce results.

Mr. Watson: Is that what you mean?

The Witness: If he thought that in the second paragraph, he hastened to correct himself in the third paragraph.

By the Court:

Q. Let's pass to that? A. The third paragraph says the applicant has improved this process by bringing into play catalysts suitable for obtaining a specific reaction which gives ethylene oxide as an oxidation product and this improved process marked a considerable step forward in the technique in the production of ethylene oxide by the direct oxidation of ethylene but the necessity of vaporizing large amounts of water requires an ex-

penditure of calories which obviously contributes its share to the production cost of the ethylene oxide obtained.

Q. Now, you have to read, that doesn't make any sense to me unless you read the next paragraph? A. That third paragraph undoubtedly refers——

Q. But you have to read the next one, don't you, to have that really make sense? A. The applicant is stating in the third paragraph what is the substance of the first two French patents that deal with this subject.

Q. But he sums it up, read the next one, isn't the next one the important one? A. The next paragraph claims an entirely new process of the present invention; namely, those applied for on July 10, 1933, the present invention limits this. It has as its object a process for producing ethylene oxide by the direct oxidation of ethylene without water vapor and with no explosion hazards. In the next paragraph, the process is characterized principally in that the ethylene-oxygen or ethylene-air mixture is diluted with a large amount of inert gas and as inert gases he specifies first a particularly advantageous form, the application or use of carbon dioxide; that is one inert gas; and then when the claim is finally resumed on page 5, methods of carrying—the bottom of page 5, methods of carrying the invention into practice, it is characterized in that the inert gas used is nitrogen; the inert gas is carbon dioxide, which owing to its partial pressure action limits the harmful reaction yielding carbon dioxide and water; the oxidation takes place in the presence of a catalyst constituted by pure silver, silver activated by gold and copper. In the use of a mixture composed of ethylene, pure oxygen and an inert gas, nitrogen, you have a new invention claimed for the first time on July 10, 1933, granted by the French patent office, an English equivalent to it filed and no American equivalent of that application filed or at any rate none issued so far in this country.

Q. And you think the American applicant for the Reissue had that before him and in his mind when he made the application? A. I think he would have been very foolish if he had not.

Q. As I understand it, you go further and you think it was so clearly reflected in the Reissue statement that he must have had it before him? A. The parties at issue are identical in each case.

Q. What was that last, I didn't understand you. A. The parties involved in the three patents are the Societe Francaise de Catalyse Generalisee. There are three patents and they are all in the name of the Societe Francaise de Catalyse Generalisee and in the third French patent they cite the first two and say we have improved it.

By Mr. Edmonds:

Q. Professor, at this point it would be appropriate to refer to the three British patents. Do you have those there? A. There is a British patent 402438 bearing a convention date October 3, 1931, which is the convention date of the French patent 739562. This patent application is similar in its construction to the original American application. It calls in each case for the simultaneous action of air or oxygen and water and gives the same three modus operandi that are given in the American patent 1998878. The second British patent——

By the Court:

Q. Just a minute, this is 402438 you are talking about? A. Yes, sir.

Q. Very well. A. 402749 with a convention date of December 19, 1931, again embodies the process for the production of ethylene oxide involving the simultaneous action of oxygen and of water and four claims covering that.

By Mr. Edmonds:

Q. These two British patents, do they correspond exactly with the first two of the French patents that you have described Nos. 729952 and 739562? A. They cover them substantially but there are differences due to differences in translation or in going through the office as far as I can judge.

Q. Well, now, we come to the third British patent? A. The third British patent on the same subject is 431966

with a convention date of July 10th, 1933, corresponding to that of the French patent 771650, which I have described as the third French patent.

Mr. Watson: I don't know whether it will change your Honor's ruling but I understand the fact to be that this is not a British patent. The patent application was opposed and the patent was never granted.

Mr. Edmonds: Well, call it a publication then, it is just the same, it is a publication.

The Court: I will allow it in.

The Witness: It is a complete specification and it claims the substance of the third French patent of the 10th of July, 1933, namely, the method of producing ethylene oxide by the catalytic oxidation of ethylene in the presence of an inert gas and in the absence of water.

By Mr. Edmonds:

Q. Are you reading from this third patent? A. Yes.

Q. That is explained in greater detail on the first page, at the bottom of the first column? A. Yes, there you have the same leit motif that you have in the French patent. The present invention is based on the discovery that an inert gas can be used to replace water as a diluent in the catalytic oxidation of ethylene and is therefore differentiated from the previous proposals by the use of a substantially dry reacting mixture.

Q. What about these previous proposals? A. The previous proposals are undoubtedly the proposals embodied in the previous specifications of this company with respect to the method for the production of ethylene oxide.

Q. In other words, the two British patents you have just told us about? A. Yes.

The Court: I don't understand one thing. It was stated that this last one never matured into a patent in England. The copy I have has the same appearance as the two that are patents.

Mr. Edmonds: There are some proceedings in England whereby a patent, after being granted, may be can-

celled or revoked in some proceeding and that might have happened, but this patent was certainly issued and is here for that reason.

The Witness: It says the complete specification was accepted July 18th, 1935.

Mr. Watson: But was never sealed. Mr. Edmonds suggests a publication and I think that is sufficient for his purposes.

By Mr. Edmonds:

Q. Look at the paragraph beginning at line 65 of Patent 433916. Does that make the meaning more definite? A. Yes, it defines the present invention once more, that is, according to the present invention ethylene oxide is produced by the catalytic oxidation in the presence of an inert gas and in the absence of water. That is claimed as a new invention.

Q. And by the same company that took out the earlier two patents in France and the earlier two patents in England? A. Yes.

Q. Do you want to proceed to relate them to the Reissue of the U. S. Patent? I think you have stated that there is no patent of the U. S. corresponding to the third British or third French patent.

The Court: How is that?

By Mr. Edmonds:

Q. There is no patent of the United States, no original patent of the United States corresponding to the third British patent or the third French patent. That is, there is no U. S. patent in existence based upon this 1933 invention of the third French or the third British patents.

Mr. Watson: Mr. Edmonds stated before and we will concede that there was no such application ever filed in the United States?

Mr. Edmonds: I haven't stated that, I said none had had been published.

The Witness: No, none has been published.

Mr. Edmonds: No patent has been issued in the United States, based on this 1933 invention.

The Court: Now, let me just summarize this, if I may, by a question, Professor Taylor. As I understand you, to summarize this briefly, this evolution of these foreign patents, removed from the question of technical language, you say this, that the evolution of the French patents, ending with this third, or what you call newly discovered patent, not suggested, not cited to the Patent Office, the evolution of the British patents, through the third or last British patent, No. 431966, disclose between the time of the issuance of the original American patent in suit and the issuance of the Reissue patent, a new method which does away with the addition of water; and you say that it is the necessary reasonable presumption that that evolution of the foreign patents culminated in those two new French and British discoveries, or in those two French and British patents just referred to must have been in the mind of Lefort when he tried to accomplish, as you claim he did, not by a new American patent, but by the reissuance of the old American patent, the same thing that had been covered by new patents in France and in England.

The Witness: Yes, your Honor.

The Court: That is putting in rather poor phraseology what you have expressed. Is that correct?

The Witness: Yes. * * * [493-508].

* * * By Mr. Edmonds:

Q. Dr. Taylor, during the latter part of yesterday's session you told the Court about the first and second French patents of the French company, with their several additions and the corresponding British patents, all of 1931, and the corresponding application in the United States fo. the original Lefort patent; and then you proceeded to bring in the third French patent of 1933, and the corresponding British patent, and remarked that there was no U. S. patent corresponding to them.

Now, I wish you would proceed to bring into that discussion the reissue of the Lefort patent, and relate it to

these French and British patents that you discussed. A. I would like to summarize, first of all, the French patent, the third French patent, 771650, application date July 10, 1933, in the following form: The patent has for its object a process for the preparation of ethylene oxide by direct oxidation of ethylene without water vapor. That is to be found on page 2 of the translation. "It has for its object a process for preparing ethylene oxide by the direct oxidation of ethylene without water vapor, and with no explosion hazards."

The resume specifies that it is a process for obtaining ethylene oxide by the direct oxidation of ethylene by means of pure oxygen or air, characterized principally in that the ethylene-oxygen or ethylene-air mixture, is diluted with a large proportion of an inert gas.

And as methods of carrying the invention into practice, they suggest the methods of carrying the invention into practice are characterized (a) by the inert gas used, as nitrogen; (b) the inert gas, carbon dioxide; (c) the oxidation reaction takes place in the presence of a catalyst, constituted by pure silver, silver activated by small amounts of gold, or copper, or of both gold and copper; (d) the reaction takes place under atmospheric pressure; or (e) the reaction takes place under a pressure which may reach 50 kilograms per square centimeter. That is the equivalent of 50 atmospheres.

Now, I called attention to the fact that an American equivalent of this particular French patent has not yet been disclosed. The reissue patent was applied for reissue on September 25, 1936, some two years after the publication of this third French patent. And it is pertinent, therefore, to examine in what respect the disclosures of the French patent, of the third French patent are reflected in the changes that come into the reissue as against the original specification.

And I would like to treat these under several headings. First of all, I would like to deal with the matter of water.

The original specifies, as is known, the simultaneous action of oxygen of the air and of water in the presence of a catalyzer, whereas the file wrapper for the reissue has a very similar phraseology: "This invention has

for its object a process for the production of ethylene oxide which consists essentially in subjecting ethylene to the action of oxygen of the air in the presence of suitable catalysts at temperatures between about 150 and about 400 degrees C."

The disclosure in the original application for the reissue, and also that given in the first paragraph of the reissue as issued, calls for the reaction of ethylene combined directly with molecular oxygen in the presence of a surface catalyst, which is also the claim of the third French patent.

In other words, the claim in the first paragraph of the reissue and of the file wrapper form of that is for the reaction of two constituents instead of three: ethylene and oxygen instead of ethylene, oxygen and water. The file wrapper also discloses that water is permissive and not mandatory——

The Court: What is that? I did not understand that last.

The Witness: The file wrapper discloses——

Mr. Edmonds: The file wrapper of what?

The Witness: Of the reissue patent, the file wrapper of the reissued patent discloses that the use of water or hydrogen is now permissive, where formerly it was mandatory.

Since the utilization of water is now no longer mandatory, it follows that there is now no longer any need in the reissue to discuss or to attempt to interpret the function of the water, and, therefore, the parallel passages, that are to be found discussing the function of the water, to be found in the original patent 1,998,878, are now no longer to be found in the reissue.

In other words, since water is now not mandatory there is no longer any necessity to interpret the function of the water. That is also in agreement with French patent No. 3, since that being an invention for the interaction of ethylene and oxygen there is necessarily no discussion of the function of the water in the reaction • • • [512-518].

* * * Those, I think, represent the influences exercised by the third French patent, as I read it, on the reissue in respect of water.

Now, we come to the question of the catalyst. The original specification called for a catalyst which should catalyze a reaction between three constituents: ethylene, oxygen and water. The reissue in agreement with the third French patent specifies catalysts which shall promote the reaction between two constituents, namely, ethylene and oxygen.

Next, I wish to point out that if one reads page 1, column 1, lines 5 to 7 of the reissue, one finds there the specification of a surface catalyst in terms of results that it achieves: "In the presence of a surface catalyst which favors the oxidation of ethylene to ethylene oxide under these conditions." The conditions have been specified as about 150 to about 400 degrees Centigrade. That is a functional definition of the catalyst which shall be used, and with respect to that disclosure in the specification I feel that it will be necessary to say something more when I come to the parallel problem in the claims that are made.

The Court: I did not quite follow you when you spoke about the catalyst referred to in the reissue as relating to reaction of two elements. I mean, is there anything to indicate they are exclusive as to that? That is what I understand.

The Witness: The catalyst is specified as a catalyst which causes ethylene to combine directly with molecular oxygen, that is, a catalyst to cause the combination of two substances; whereas the first specification calls for the subjecting of ethylene to the simultaneous action of oxygen and of water in the presence of a catalyzer, and, therefore, a catalyzer for three reactants.

The Court: But it could be the same catalyzer under the specifications of both patents?

The Witness: It might be.

In further specification of the catalyst one reads on page 1 of the reissue, column 1, lines 46 and following:

"Such a surface catalyst as one composed of silver in finely divided form and which may be disposed within the tube on a supporting material or in other known ways."

Further, in column 2 it is specified the surface catalyst is preferably silver as stated but other metals such as bismuth and antimony may be used; likewise oxides of these metals or likewise a combination of these metals or their oxides may be used. Experiments have also indicated that the catalysts from silver activated by the addition of small amounts of gold, or copper or iron"——

Now, I wish particularly to call attention to this quotation from the patent specification, because this is for a catalyst to cause ethylene and oxygen to combine, which is what the third French patent calls for, and it calls for precisely the same catalyst: silver, silver activated by small amounts of gold or copper.

The bismuth and antimony and the iron are in the reissue but for a different purpose than that for which they are in the original specification. There are in the original specification a large number of catalytic agents specified, and these are catalytic agents for the simultaneous action of oxygen and of water on ethylene. Now, the catalysts are catalysts for the action of oxygen on ethylene and one presumes the same list of catalytic materials will not be as efficient in the three component system as in the two component system, and hence the number has been considerably restricted. So much for the catalyst in the specification.

I turn now to the question of heat absorbing diluents because it will be noted that the French Patent No. 771650 specifies the incorporation in the ethylene and oxygen mixture of diluents such as nitrogen and carbon dioxide.

I find on page 1, column 1, line 32, I think it is, "Oxidation of ethylene takes place with the giving off of heat, and it is, of course, desirable to maintain the temperature of the zone of reaction within the range specified. This can be facilitated by suitable dilution of the reaction gases such as that accomplished by the use of air as the source of oxygen, that is, using the nitrogen as a

diluent and some water or carbon dioxide in addition to that formed can be admitted to the mixture." That is, the use of the carbon dioxide as a diluent and as an addition water is specified as a diluent. Finally it says, "Hydrogen may similarly be added," and suggesting that hydrogen may also be used as a heat absorbing diluent, whereas my experience would lead me to suggest that it would combine rapidly with the oxygen present in the system and be converted into water, and it would be the formed water that would, if anything, act as a diluent.

Now, I find no mention in the original specification of anything concerning heat absorbing diluents, and to that extent it seems to me that the reissue has departed from the original and departed in a direction which is suggested by the third French patent 771650.

Now, I would like to turn to the corresponding items in the claims.

The Court: Before you pass to that, let me ask you one question: Did you find that there was similarly no mention of the heat absorbing diluents in the earlier French patent?

The Witness: I would have to look that up specially, but my recollection is that that is so. Now, if I might take up the claims of the Reissue with respect to these three items, claims 1 to 7 each specify three component reaction systems, as does the original, and do not appear to me to have been influenced in any way by the third French patent. With respect to claim 8 the difference is at once manifest. Claim 8 derives, so far as I can see, from the third French patent in two respects; first, the process of making ethylene oxide by the direct chemical combination of oxygen with ethylene in the proportion of one atom of oxygen to one molecule of ethylene. The third French patent specifies the direct oxidation of ethylene and says without water. This says the direct chemical combination of oxygen with ethylene and does not mention water. Still referring to this question of the presence or absence of water, claim 9 similarly covers the direct chemical combination of oxygen with ethylene which comprises forming a mixture containing ethylene

and molecular oxygen and a heat absorbing diluent, claiming therefore something which in the third French patent was claimed as a new invention. Now, turning back to the question of the catalyst.

By the Court:

Q. Just before you get on that, will you please let me ask you a question. Taking up the 8th and also the 9th claims, maybe you are going to discuss that in the light of the catalyst. What I had in mind, I wanted you to say something about the phrase "In the presence of water," found on the 34th line and the 26th line of the 8th and 9th claims? A. That is on line 34.

Q. In the 8th claim you will find it on line 34 and in the 9th claim you will find it on line 25? A. May I discuss that with reference to the catalyst?

Q. Yes. A. The catalyst as disclosed, as claimed, in claim 8 represents a very broad claim because it says that I shall do this reaction, with an active surface catalyst of a material having the catalytic characteristics of silver. What are these catalytic characteristics of silver? These catalytic characteristics of silver are these: Catalytic characteristics of silver which favors the direct oxidation of said ethylene in said mixture by said molecular oxygen to form what? To form oxidation products containing ethylene oxide in the presence of water.

Now, in the first place, that is a functional definition of a catalyst. In the second place, that is a definition of a catalyst of extraordinary breadth because it says that if anyone now or in the future finds a substance which will cause ethylene and molecular oxygen to form oxidation products containing ethylene oxide in the presence of water, they will come within the claims of this particular patent whether that was known to the applicant at the time of this application or not.

May I give an illustration? In 1921 Willstatter showed that ethylene and molecular oxygen could be oxidized in the presence of an osmium catalyst. He showed that the reaction began a little above 100 degrees and that it was practically complete with the consumption of all of the

oxygen at about 200 degrees and that the products were carbon dioxide and water. So far as I know nobody has ever since produced ethylene oxide by the oxidation of molecular oxygen and ethylene with an osmium catalyst. But if someone comes along and succeeds in forming osmium into such a form that the uneconomic reactions of producing carbon dioxide and water can be suppressed and the ethylene oxide becomes an important product of the reaction, oxidation products containing ethylene oxide in the presence of water, so far as I read the functional nature of this particular claim, that discovery which is not yet exhibited in the literature would be barred from application by a claim of the breadth of this particular claim. In other words, this particular claim, instead of doing as one might be led to suspect from the patent specification, restricting down the number of materials in which this particular process can be carried out, is in reality spreading out to include not only those that are known now but any such as may be found in the future to oxidize ethylene and molecular oxygen to form oxidation products containing ethylene oxide in the presence of water.

Q. In other words, you mean that when you use the words "having the catalytic characteristics of silver," that is very much broader than using the words that are in the ninth claim, "With an active surface catalyst metal comprised essentially of silver"? A. Oh, yes.

Q. In other words, one has to be essentially silver and the other does not have to be silver at all. Is that what you mean? A. That is exactly what I mean.

Q. Because you can find a lot of other metals that would have the catalytic characteristics of silver? A. So defined. These catalytic characteristics are defined, they are defined as those which favor the direct oxidation of said ethylene in said mixture by said molecular oxygen to form oxidation products containing ethylene oxide in the presence of water.

Q. And you say there are a large number of those? A. No, I don't say there's a large number but I say if anybody finds one not disclosed before, then he would immediately have this broad claim standing against him.

Q. I understand. A. The functional nature of the catalyst does not end unfortunately at that particular point. The functional nature of the catalyst is contained also in the following clause, not only that you produce these oxidation products but you must define your catalyst in terms of "correlating the passage of said mixture through said reaction zone in the presence of said catalyst and the controlled elevated temperature of said mixture and said catalyst to effect said oxidation of said ethylene directly to form substantial amounts of ethylene oxide." There is a tremendous amount of correlation to be carried out but I find nothing in the specification which tells me how I shall carry out that correlation and what is the nature of the correlation that I should get. I find 150 to 400. I don't find anything about the velocity of passage.

Q. Is that true of the third French patent? A. The third French patent actually gives some specification. It gives a perfectly definite specification under the first method of operation, page three, it specifies a mixture, for example, 66% carbon dioxide, 3.4% of ethylene, 6.3% of oxygen and 24% nitrogen; a mixture of air, plus ethylene plus CO_2. It specifies the reaction temperature. It specifies the catalyst used. It specifies, it says that in tests conducted by the applicant the velocity of the gaseous mixture varied between .85 and 250 litres per hour over a catalytic distance of 60 centimeters. The tube was 63 millimeters in diameter and the reaction temperature about 375 degrees Centigrade, a quite specific correlation of the various factors that enter into the matter. The same difficulty arises in the specification of the catalyst in claim 9.

Q. I thought you said it was more restricted? A. Yes, but the same functional definition of the catalyst occurs in claim 9. It will be obvious that there was a particular difficulty arising in connection with the specification of a silver catalyst for the direct oxidation of ethylene with molecular oxygen. That difficulty arose because previously there were in the literature records of people who had reacted ethylene with oxygen in the presence of a silver catalyst, namely Willstatter and Bommer and Reyerson. In order therefore to specify the particular

type of silver, it became necessary to avoid the anticipatory disclosures containing the reaction of ethylene and oxygen in the presence of silver made previously. That has been accomplished by the functional definition of the silver catalyst.

It has been specified as a catalyst composed essentially of silver, which favors the direct oxidation of said ethylene in said mixture by said molecular oxygen, to form oxidation products containing ethylene oxide in the presence of water, and which does not favor the existence in said products of substantial amounts, of aldehydes. That is a functional definition of silver, in terms of the results to be achieved. And in addition it is anticipated, so far as silver is concerned, by the French patent 771650, which has no American analogue, and which after October 13, 1934, was published.

Concerning, therefore, this silver catalyst, I would say that it is specified in terms of the results to be accomplished; and, secondly, those results are already claimed in an earlier French patent, 771650.

Finally, there is the same correlation defining the silver catalyst as I outlined in connection with Claim 8.

That, I think, sir, expresses my present views with regard to the influence exercised by French 771650 on the reissue patent. * * * [518-531].

The Court: * * * but I would like to ask these questions:

Professor Taylor, you have not yet gone into the question of whether it is possible to follow the teachings of the Reissue Patent and successfully produce the desired result, as one or more of the other witnesses have done. But with that in the background, I would like to see whether I understand what you have said, summarizing it very briefly.

The main point which I understand you have been endeavoring to bring out is that you feel, first, that there is a very definite difference between the original patent and the reissue, in that the original provides for the use of the three elements, including water, whereas the reissue, according to your analysis of it, leaves water out

entirely in the reaction process, the major process that is stated; and then, secondly, if I understand you correctly, you believe that that change is very definitely reflected, or very definitely reflects the third French patent, and leaving out the matter of the catalyst and the diluents, those may be said to be the two major thoughts that you now have.

The Witness: Yes, sir.

The Court: I do not mean that you do not think the others are important, but those two, if I understand you correctly, are your two major points——

The Witness: Yes, sir.

The Court: In your testimony so far. Now, taking up the first, is it your contention that this departure from the mandatory use of water is such a departure in the art as you understand it as must necessarily lead one to the conclusion that the two processes are in fact very distinct? I am not trying to get you into any legal question as to whether in law they are distinct or not, but whether in chemistry they are distinct. In other words, suppose you were told to avail yourself of the prior art method, and to proceed to manufacture ethylene oxide, would you feel that if you had to do, or had to give directions to some one to do it with these two processes, one with the use of water and one without the use, they should be treated as definite, distinct methods?

The Witness: Oh, yes, your Honor. That is just what is abundantly evident in the three French patents. In the original patent they made a process for the manufacture of ethylene oxide, using ethylene, oxygen and steam. There were various additions to that patent, representing increasing knowledge of the inventors concerning the process in question.

That was directed also in the second patent. But still the process was the interaction of three elements.

Then the French company, who had gone through this whole program of work, came along and said, we have found an entirely new process, for which we use a new invention, for which we claim very considerable advantages over the previous ones, in that we now no longer

need to put in the expensive water, and have to take it out again, but we can work entirely without water added to the reacting constituents.

And I rely upon the evidence of the French people themselves, that they had two entirely distinct inventions. And the fact that they filed a third patent specifying this indicates to me quite definitely that on or about July, 1933, they discovered that they could make a much better process than they had ever before, and they proceeded to file an application asking for protection for that process.

The Court: Well, let us assume that it is better, and let us assume that under the French law it would be entitled to patent differentiation; but what I would like to develop a little more is why you differentiate it purely as a chemical question. You say it is more advantageous. Well, we have a lot of patent matters where alternates are more advantageous; but they may be so commonly suggested as an alternate that they are not entitled to separate patents. In other words, they may be something that is suggested by the first method, and something which one skilled in the art would normally try. So the fact that it is an improvement, or better, would not necessarily answer my question.

I understand you to say that it is not only an improvement and better, but it is in the art to be considered as really an entirely different chemical method. That is what you say. You see, my difficulty is I am laboring under the difficulty of not having basic training in the art. Now, to tell me, a layman, that you can make this by leaving water out, or putting it in, does not get me very far, because I look upon water as the commonest of the substances, and something which is not expensive —you refer to that—and it is readily available; and I simply visualize something where, well, you can use water here or not use it, as you see fit.

Now, you have told me that in your opinion the very absence of water, the very fact that you say "Don't use water" is a radical change in the method. Now, it is right on that point that I do not quite get the full technical reason for it being so radical and so important a difference.

Do I make my question clear?

The Witness: Yes. The only way in which I can point out to you how radical a change it is, is that it is evident from the literature that people before, attempting to partially oxidize ethylene with gases containing molecular oxygen had succeeded in producing useless products, carbon dioxide and water. Lefort came along and said, if you will allow oxygen and molecular water to react with one another, you can get a useful product, ethylene oxide.

The same company came along at a later stage and said, we have done what other people have failed to do before; we have taken two constitutents and obtained the desired product.

It is scarcely true to say that water is a cheap commodity that can be put in and taken out at will. It has to be remembered that that water has to be raised to a working temperature—shall we say 200 degrees Centigrade, which requires heat, and, therefore, calories, and therefore expense to produce that heat. That is the advantage which is claimed for the process by the French patentees in their third specification.

The Court: You see, I can not assume that just because the French Government thought that the change, the leaving out of the water, entitled the inventor to another patent. I can not assume for the purposes of this practical construction that that answers the question. They may be right, or they may be wrong. Let us assume that the French patent, as far as France goes, is valid.

Mr. Watson: May I say on that, if the Court pleases, that in France an application is filed, and with no examination whatever granted. It is like a copyright in this country. The issue of a French patent does not mean anything in the sense of American law.

Mr. Edmonds: That is of no significance here because there is a third British patent corresponding exactly to the third French and which was examined for novelty.

Mr. Watson: And that one, however, as I told Mr. Edmonds yesterday, was not issued; that patent was never received.

The Court: Well, I can make my question practically the same assuming there had never been any French or British third patents issued, and, therefore, you can assume you can not trace the influence of any other person to the Lefort reissue, but if you find that to be the case, wherever he picked it up, whether suggested by somebody else or whether through his own brain, he evolved this method where, as you describe it, you say now it is mandatory that you leave water out, you say previously that the earlier patent said it is mandatory to put it in, at least, he says how you can do it in the reissue without any water and claims that is novelty and very much less expensive and more effective.

Now, I understand you to say, Professor Taylor, that you think, even putting the question as I have put it, leaving out the presumption that might follow from what has been done by others, and the legal effect that other Governments have attached to that, leaving all of that out, you would still say regardless of that if that was not in the picture you nevertheless feel that one who says, "Make this without water," is telling the laboratory man to do something entirely different in the art from telling him to make it with water? You stand or fall on that, do you? And I am talking again only as a practical chemist.

The Witness: Yes, sir.

The Court: Not from any legal point at all but just leaving all of that out of the question.

The Witness: And I would indicate the general truth of that particular assertion by pointing out that the process becomes a valuable process when it is possible to leave out the water.

The Court: It becomes valuable, becomes more valuable, according to your theory, does it?

A. Well, shall we say that it becomes economical.

The Court: In other words, it is the preferable method from a commercial standpoint, is that it?

A. Enormously preferable.

The Court: So that you think you have here not merely a departure, which is a definitely material one from some prior art, but a departure which results in a commercial improvement?

A. Your Honor, may I express it this way: that if the original and the reissue had come before this Court in the form of the original and a new patent covering the improvements in the manufacture of ethylene oxide by the elimination of water, I don't think that I would have been on this stand, because it would have been apparent to me that that reflected an improvement. What I point out is that improvement, which bears an international convention date of 1933 has turned up in a patent which bears an international convention date of 1931.

The Court: Will you state your first remarks again, that you do not think you would be here? I did not quite follow that.

A. If the question were the consideration of a patent for the manufacture of ethylene oxide involving three elements and the catalyst, and if it had been followed by a new patent bearing a new international convention date, for a patent for the production of ethylene oxide, from ethylene and molecular oxygen and constituting an improvement on the preceding one, then I would not be here because my principal argument that I have placed before the Court would have no longer been valid, and for that reason I would not be here.

Mr. Edmonds: You would then have a 1933 patent for a 1933 invention?

A. Yes, sir. Now, what I have found here is an invention which the French people claim is a 1933 invention appearing in an American reissue with a 1931 date.

Q. In the situation you have just been discussing, this hypothetical one, there would be two different patents, one a 1931 patent and the other a 1933 patent?
A. Yes, certainly.

Q. And what you are talking about is the extent of the improvement of that 1933 patent over the 1931? A. I should regard the 1933 as a definite improvement over the 1931.

Q. But that is no parallel to what we have here, in fact it is quite the opposite? A. Certainly.

Mr. Edmonds: And in that respect which you just mentioned, we have a 1931 patent for a 1933 invention.

The Court: Now, let me ask you one other question: the prior testimony on your side was virtually that one would have to thrash around indefinitely before hitting upon the satisfactory catalyst under these specifications and claims. I understand that you in effect intimate that you feel, if you believe that to be true, that you said that the catalyst in claim 8 is extremely broad in function and the same is substantially true of claim 9, but now I am going to ask you if you will be a little more specific: Do you agree or not with the prior witnesses who have said that they thought it was impossible to, without great labor, to hit upon the exact catalyst that would do the trick under this patent?

A. In my view, and specifically referring to claim 9, it would require a considerable amount of experimental work to perform all the correlations that are called for with a view to finding the best catalyst.

The Court: Well, is or is that not true of all work of this kind in this field? In other words, as a practical matter would you expect to find the catalyst more definitely defined?

A. Your Honor, I think this involves a question of deficiency of specification, and one can give a lot of testimony with regard to that. I can give you an example if you so desire.

The Court: Well, the prior testimony on your same side of the case has been to the effect that the specifications are far too broad and vague. Now, what I want to ask you is, again leaving out any legal requirements or what would be the legal prerequisites and doing it entirely from your professional standpoint, if you were

handed this description, if you were handed either one of these descriptions combined in claims 8 and 9 and were directed to proceed to manufacture commercial ethylene oxide, would you be brought up by that direction suddenly with the feeling: "Now, I have got to have more than this"?

A. Quite definitely, and I think I can amplify that conclusion by a question of history: at one period in the development of this case I made up my mind to make a silver catalyst to convert ethylene into ethylene oxide, just to see if I, as a skilled investigator in the field, would have a success. I made up my mind to use a catalyst support material which I was using for other purposes in my laboratory, and to support silver on that material in some way or other. The carrier that I intended to use was one that I am using daily in the laboratory, and was activated alumina, a well known carrier in the art today. The result of that experiment was, I never performed it, but it was told to me by Mr. Carter, who stated—— • • • [532-546].

The Witness: • • • I am referring to the test which is in the stenographic transcript in Volume 2, in which there is a definite statement that in a catalyst produced by impregnating activated alumina with silver the product was carbon dioxide and water.

Now, the condition is much more extraordinary than that because, let us suppose that I had taken exactly the same chemical substance, alumina, but instead of taking the form of alumina such as is found as activated alumina, I had used it in the form of high temperature sintered alumina, that which is known chemically as corundum, if I had taken that same chemical compound, Al_2O_3, and impregnated it with silver I would have obtained an active catalyst as indicated in this testimony of the stenographic transcript. Therefore, we have the situation, here are two catalysts, one of which is alumina as a support with silver on the top, the other of which is alumina as a support with silver on the top, one works efficiently to give CO_2 and water; the other gives a reasonably profitable yield of ethylene oxide. The chemical composition of the two catalysts is identical, the difference apparently lies

in the property of the catalyst in terms of the structure of the underlying support in the two cases and the nature of the influence of that underlying structure on the silver catalyst that is laid on the top.

The Court: Now, you say that the third French and British patents are sufficiently specific but that this reissue is not on this point?

The Witness: May I examine the British patent?

The Court: Maybe I asked you the same question before.

Mr. Edmonds: Well, he read you a great deal of detail which is represented in the French patent. Maybe the witness has not had occassion to consider whether the sum total of those are sufficient but it certainly is in a wholly different category from the reissue, which gives no figures at all.

A. It says the catalyst employed is pure silver and does not—it says it can be silver or silver activated by gold or copper or both gold and copper.

Q. Then you would say that that was too vague? A. I think that it would require experimentation to determine which particular silver catalyst would work, yes.

Q. Well, now, if the test that the law should apply to a specification in technical processes of this kind is whether those skilled in the art can take the description or specification and by following that accurately accomplish the desired result without having to seek elsewhere for aid to any material extent, if that is the test that the law should apply in determining whether the patent should be upheld or overthrown, I would think it would have to follow from what you said that this third French and third British patent should never have been allowed. Do I make myself clear? A. Yes, but of course, that is a legal point upon which I am not competent to express an opinion.

Q. Yes, I am not expecting you to pass upon a legal question but I do understand you now to say that you think that in so far as the catalyst question goes that neither the reissue, the British nor the French third

patents are sufficiently specific? A. Yes, but that is a subsidiary defense, isn't it, I mean inadequate disclosure?

Q. I understand it is and you think the main reason why the defense here against the reissue patent is sound is that it covers a distinctly new thing, but I have gotten into the other question of sufficiency of specification and I just want to get your views? A. Well, that would be a ground for attack, the ground of inadequacy of disclosure.

Q. However that may be, you are firmly of the conviction, as I understand it, that again leaving aside any legal question, you are firmly of the conviction that, as you understand the art, when one talks about making ethylene oxide by the use of three elements, he is talking about a distinctly different process from the one where he talks about leaving water out and using only the other two elements? A. Yes, sir.

The Court: I think I understand that.

By Mr. Edmonds:

Q. Is there something more you can tell us right along that same subject, that same topic, in this respect: Is there something about the effect of the water when it is introduced in the three component process, its effect on the catalyst itself, its effect on the reaction, its effect in requiring a difference in the catalyst itself, its effect in requiring a different correlation of the factors that enter into the catalyst? A. Well, of course, one's answer to a question of that kind must be, of course, largely speculative on the basis of one's general knowledge of things in this field and of the action of various reagents. I would say that the effect of the water probably resides in the fact that it is a partaker with the other two constituents of the sites on the surface which are available for reaction.

Mr. Barrows: The catalyst surface?

The Witness: The catalyst surface, that depending upon the ratio of ethylene and oxygen and of ethylene, oxygen and water. There will be different opportunities for different reactions to occur. In the first place, the formation of ethylene oxide or, if the oxygen is present

on the surface in very considerable amounts, the oxidation of that ethylene before it leaves the surface into undesirable products, carbon dioxide and water; and the three component system determines the relative amounts of these three reactants on the surface and the ratios of ethylene and oxide determining the nature of the products which are obtained.

By the Court:

Q. You have not specifically in your last analysis said anything about the phrase "in the presence of water," used in both of the claims, but if I understand you correctly, you mean to say that that water which is not put in at all as part of the reaction, that water is not the water that might be added as part of the original reaction but it is rather the result of what takes place, is that right? A. Yes, because it says "To form oxidation products containing ethylene oxide in the presence of water."

Q. Well, my point is just this, in layman's language, do I understand you to say that no one could reasonably in the art construe that phrase as suggesting that you started off with the addition of water? A. If it was intended to convey the idea that one ought to start off with water, why shouldn't it be in the first three or four lines?

By Mr. Edmonds:

Q. In the third French patent, the process of the third French patent——

Mr. Watson: Is that an answer or question?

The Court: He answered it by asking a question.

The Witness: I will frame it in the form of an answer. I think that refers to water produced in the reaction because if it had been intended to cover the addition of water to the reaction mixture, I would have expected to find it in the first lines of the patent claims 8 and 9.

By Mr. Edmonds:

Q. What about the process of the third French and the third British patents. Is that a process where ethy-

lene oxide is produced in the presence of water even though no water is put in? A. That is the claim of the third French and the third British patent.

By the Court:

Q. Well, now, are you or are you not somewhat omitting or overlooking the sentence which has been discussed a good deal in line, beginning at line 35, the first column of the Reissue patent "This can be facilitated by dilution of the reaction gases, such as that accomplished by the use of air as a source of oxygen, and some water or carbon dioxide in addition to that formed." In other words, some water in addition to that formed can be admitted to the mixture in the reaction zone if desired? A. As a heat absorbing diluent.

By Mr. Edmonds:

Q. That is what is to be facilitated? A. Yes.

By the Court:

Q. Put in for an entirely different purpose? A. Yes.

By Mr. Edmonds:

Q. Where did that process come into this evolution which we are talking about? A. French patent 771650.

The Court: He has already covered that. I think I understand your point. Have you finished?

By Mr. Edmonds:

Q. I was going to ask the witness one question paralleling the question you asked and referring to another one of the witnesses, namely Mr. Pyzel, who testified yesterday. I would like to ask you if you are in accord with him in the statement he made which, as he expressed it, was when you have said silver, you have said nothing? A. Anybody skilled in the catalytic art knows that you have said nothing.

Mr. Edmonds: That is all.

By the Court:

Q. Well, now, that suggests one other question, Professor. I suppose to be logical then you would have to say that on this point, this latter point that Mr. Edmonds just referred to you would have to say that if only the original U. S. Patent were before you, that although it enumerates a great range of catalytic possibilities, that nevertheless it is also too vague on the question of telling you what catalyst you should use to get the desired results? A. In my view, the patent is attackable on the basis of inadequacy of disclosure.

Q. That is, you say the patent— A. The original patent.

Q. The original patent? A. Yes.

Q. And, of course, the Reissue patent? A. Yes.

By Mr. Edmonds:

Q. But its disclosure goes much further, doesn't it, than the reissue? For instance, it includes some examples which tell you something about what to do? A. Yes.

Mr. Edmonds: That is all.

CROSS EXAMINATION.

By Mr. Watson:

Q. What you have said about the indefiniteness of the disclosure, particularly in your last remark, "when you said silver, you have said nothing." Is that, in your opinion, a peculiarity of the Lefort process or do you mean that that is a general statement that is equally applicable to all catalytic processes? A. I mean that good patent applications will specify as closely and as carefully as possible the particular method of preparation of material in order that with a minimum of labor possible somebody interested in the process can proceed to repeat the process * * * [547-558].

* * * Q. You are a patentee? A. Yes, sir.

Q. I show you patent 2168590, and ask you if that is yours (handing patent to witness). A. Yes.

Mr. Watson: I ask that this be marked for identification * * * [559].

* * * (Patent No. 2168590, entitled "Catalytic Alkylation of Aromatic Hydrocarbons," marked "Plaintiff's Exhibit No. 10 for Identification.") * * * [561].

* * * Q. Dr. Taylor, please look at that patent—and you may quote from it, the statement as to the nickel catalyst. A. I said, "The reaction producing methane was first detectable at about 150 degrees Centigrade. Thus it is quite evident that, with an active nickel catalyst, whereas at 135 degrees," so on and so and so, a lot more.

Q. That is all about the catalyst? A. Now, your Honor, I would like to put in, in the form of testimony, the fact that nickel catalysts have been prepared in active forms since 1900, or even perhaps back of that time. There are the most specific instructions possible with regard to the preparation of active nickel catalysts. Many thousands of them have been made. Many hundreds of them have appeared in the patent specifications. And I think that anybody skilled in the art knows how to make an active nickel catalyst. If they do not know, they can read my paper, where I publish the details as to how that particular nickel catalyst was made.

Q. Now, do you mean to imply that the preparation of an active silver surface catalyst was not known and stated in the literature before 1931? A. I have never seen any reference to an active silver catalyst for the oxidation of ethylene to ethylene oxide prior to this particular patent.

Q. That was not my question, and I will have to pursue it. Do you mean to imply that active surface silver catalysts were not described in the literature, and how to prepare them was not described in the literature, for oxidation processes before 1931? A. I used the silver gauze catalyst for the oxidation of methane in 1918.

Q. Well, please answer my question. A. Haven't I answered your question?

Q. No, my question is, Did the literature before 1931 contain descriptions of the preparation of an active surface silver catalyst as an oxidation catalyst? A. Yes.

Q. One of them is Benton & Elgin? A. Yes.

Q. That is a very commonly known disclosure, is it not? A. Yes.

Q. And if one would follow that procedure with silver, and then use the silver by passing ethylene and air over it, at a temperature between 150 and 400 degrees, he would conduct the Lefort process, isn't that true? A. Which Lefort process? The French patent, three?

Q. Well, he would get ethylene oxide, is that not true? A. I don't know.

Q. Did you ever try it? A. No.

Q. Have you given all your testimony of opinion here without ever trying to make a silver catalyst, passing ethylene and air— A. Yes, sir.

Q. —over it? A. Yes, sir.

Q. What oil companies were you consultant for? A. The M. W. Kellogg Company, and companies that are associated with it.

Q. What? A. The M. W. Kellogg Company, and Petroleum oil companies that are associated with it, in various researches which I——

Q. Well, is the Standard Oil of New Jersey one of those? A. I think that the Standard Oil of New Jersey is in a part of the agreement.

Q. Do you know whether the Shell Company is? A. The Shell Company may be in on some of the agreement. I don't know. My relations are with the M. W. Kellogg Company.

Q. That is a construction company, isn't it? A. Yes, sir, construction and research company.

Q. Well, research on machinery and equipment? A. Oh, no, new processes.

Q. When did you first study the original Lefort patent? A. About twelve months ago.

Q. And the reissue? A. At the same time.

Q. When did you first hear about the processes being commercially operated by passing ethylene and air over a silver catalyst? A. I was told that about a year ago.

Q. Were you informed of the demonstration conducted by plaintiff ten days ago, or two weeks ago, at South Charleston? A. Yes, sir.

Q. Did it strike you that the test as there conducted was a normal simple preparation of a silver surface catalyst? A. That is one method of preparing a silver catalyst on a support.

Q. And one method which was well known prior to 1931? A. Well, I had never heard of its application to filtros before.

Q. Well, the preparation and deposit of silver on filtros, or on carborundum or fused aluminum oxide. were all well-known things? A. I had never heard of the application of silver to filtros until last week.

Q. I am excluding filtros from my question, and saying that the process was well known for the application to a support of similar character, for example, carborundum, or fused aluminum oxide. A. I heard of that from Mr. Carter.

Q. Well, now, Dr. Taylor, haven't we all agreed that the literature before 1931 commonly stated such a procedure for preparing an active silver catalyst? A. Such a procedure? What is the procedure?

Q. What procedure do you think I am talking about? A. The procedure of putting silver on some kind of a support.

Q. Well, I am talking about the procedure which was followed at South Charleston, in plaintiff's demonstration. A. You can deposit silver on pumice that way, yes. I probably heard about that before.

Q. Or deposit it on any suitable support. A. That is a regular method of putting catalytic metals on support materials, yes.

Q. And it was well known before, generally known before 1931 as such? A. The procedure of putting catalytic metals on support materials.

Q. On support materials such as glass wool, silica fibres, fireclay, alundum, and unglazed porcelain, isn't that right? A. Yes.

Q. Since Dr. Reyerson gave his testimony in the case —I think you were not present at the time—have you read his testimony? A. Yes, sir.

Q. Anything in his expressed opinions that you take exception to? A. No. In general I agree with him.

Q. Well, there are two points of Dr. Reyerson's testimony especially that I would like to get your views on. One, you recall he referred to the statement in the reissue patent that molecular oxygen was used, and he said that to a chemist the term molecular oxygen meant that you could use pure oxygen, and therefore dry oxygen. Do you agree with that? A. Molecular oxygen is O_2, and can be dry, yes.

Q. Well, you agree that the specification of molecular oxygen to a chemist means that you can use dry oxygen? A. Surely.

Q. The other point of Dr. Reyerson's testimony on which I would like your opinion is that in answer to a question of the Court he expressed his conviction that so far as concerns the original Lefort patent, the amount of added water in the entering gases that he referred to, and that you have been referring to, was of no materiality and significance. It was that there should be some, but there was nothing critical in the amount. Do you agree with that opinion? A. Of no materiality?

Q. Yes. A. Am I expected to answer all of these questions independently?

Q. Yes, or all collectively, any way you want. A. I think it is quite evident from the statement in the patent as issued that water is a material constituent of the process.

Q. But the amount of it is not material; is that it? A. The amount of it, it would seem to me, would depend

entirely upon the conditions under which the experiment was being performed.

The Court: I would like to interject one question here. I do not want to unduly interrupt you, Mr. Watson.

Mr. Watson: Yes, sir.

The Court: But as long as I have it on my mind—I neglected to ask it before—as I understand it, Prof. Taylor, the first seven claims of the reissue patent are the same as the first seven claims in the original patent, and since all of them make water mandatory, the use of water mandatory in the process, water or steam, I gather from what you have already said in response to my various questions that to be logical you would have to say that those claims were not responsive to the specification of the reissue patent——

The Witness: Yes, sir.

The Court: —as you read those specifications.

The Witness: Yes, sir.

The Court: That is all.

Q. (By Mr. Watson) I will call your attention to the following from the transcript, beginning at page 259:

"The Court: The point made by your counsel in argument is that water is an essential part of this patent.

"The Witness: Yes."——

I will omit some words without changing the sense.

"The Court: Now, my question is, Well, then, do you mean to say that because the patent does not tell you how much to put in, it is too vague? Is that what you mean?

"The Witness: Well, I admit that it is vague; but I think it is a requirement that water must be put in.

"The Court: Do you think that can be worked out sufficiently by one skilled in the art? The application of water is a pretty common thing, isn't it, in a lot of processes. Is it necessary to a trained chemist to tell how much water he should add to the process?

"The Witness: No, I do not think it is essential at all, how much water."

Mr. Edmonds: He changed that.

Mr. Watson (Reading):

"The Court: Then, would you say that the fact that the amount of water is not specified would make any difference?

"The Witness: It is not a material difference."

Do you agree with that expressed opinion of Dr. Reyerson? A. Not in detail.

Mr. Edmonds: May it please the Court, may I ask, before we go further, that the words "at all" be changed to "to tell." The witness has told me that is what he said, and he said he was taking the question, answering your question just as you stated it.

Mr. Watson: I won't change it until I hear the evidence on it, because, if the Court please, we have had ample opportunity for that witness to take the stand and say he wanted to change his testimony.

The Court: What is the change? What does it amount to?

Mr. Edmonds: It amounts to very little.

Mr. Watson: It is changing the answer from, "No, I do not think it is essential at all how much water," and they want to change it to, "No, I do not think it is essential to tell how much water." There is more emphasis on the "at all."

Mr. Edmonds: I am merely putting it in at this time, so that if counsel want to make the change now, in talking with this witness, he will have the opportunity to do it. Mr. Reyerson, in reading the testimony told me that at that point he used the words which appear two lines above in the question, and that this is not what he said, but what he actually said——

The Court: Well, he can correct that later on.

Mr. Edmonds: Yes. He speaks as a matter of recollection of what he said, what he said in the answer.

Mr. Watson: Then the witness went on, "It is not a material difference."

Q. (By Mr. Watson) You say you agree with that? A. The teaching of the patent indicates that there are various methods of conducting the process, one of which——

Q. Let us confine ourselves, if you will, please, to the one question. Is it necessary to a trained chemist to tell how much water he should add to the process? Will you answer that? A. I should say it must be a definite quantity of water.

Mr. Edmonds: But you are permitted to complete your answer as you wish, Doctor. You were interrupted in the midst of the answer before. You can always complete your answer, if you want to.

The Witness: Well, I will try to answer it if Mr. Watson wants.

Q. (By Mr. Watson) I am reading the Court's question, the next one, "Then, would you say that the fact that the amount of water is not specified would make any difference?

"The Witness: It is not a material difference."

Do you agree with that? A. Well, you see, I have already pointed out in my own testimony that there are definite indications as to the amount of water in the three examples chosen. I have shown that in the first one——

Mr. Watson: I do not want to review your testimony; I just ask you whether you agree or disagree with the statement, first, and you may explain later.

The Witness: What is the statement?

Q. Dr. Reyerson, in response to the Court's question, reading: "Well, would you say that the fact that the amount of water is not specified would make a difference"? replied, "It is not a material difference." A. I would disagree with him.

Q. Now, you started to speak of one of your answers in your testimony on direct, where you indicated that you had referred to an amount of water which was in one of the examples of the original patent, and you calculated that at 30 per cent of water? A. Yes.

Q. Why did you assume equilibrium was necessary? A. Because I was injecting water.

Q. Well, could you not inject water which would give a water percentage of less than 30 per cent? A. Yes.

Q. You could do it anywhere from nothing to 30 per cent? A. Yes.

Q. I was somewhat surprised in your direct examination to hear you, in connection with the process involved in the case, refer to the silver on an inert carrier such as silica gel. Do you mean that silica gel is an inert carrier in this process? A. It was defined as an inert catalyst—as an inert support for the oxidation of ethylene to carbon dioxide and steam by Reyerson in his paper.

Q. I will have to repeat my question: Did you mean to give the Court the impression that silica gel in this process we are dealing with is an inert support? A. I have no idea, because I have not done the experiment myself. I should judge that it is an inert support.

Q. Then you are not familiar with the literature on this subject? A. I have read a lot of it * * * [562-577].

* * * Q. At the risk of repetition, I will have to ask you again the question: Did you ever try to use activated silver on a support or not at a temperature over the range of 150 to 400 degrees, passing ethylene and air over the silver, with or without added water entering the mixture, and fail to get ethylene oxide? A. I never did such an experiment.

Q. You never tried even that experiment, so you don't know what you would get? A. Never did.

Q. In your testimony about the original United States patent, where you have expressed the opinions we have heard on the subject of water, is it not true that we can limit our consideration on that subject of water to water in the reaction zone? A. Yes, sir.

Q. Obviously there is no role or reaction before the mixture gets to the reaction zone and none after, so what we are talking about is in the zone of the catalyst? A. Yes.

Q. I did not understand your answer to the Court's question a moment ago; you have spoken of the processes

of the original patent and the reissue patent as entirely different, and I think I quote you in referring to them as fundamentally different. Now, considering them from the mechanical viewpoint, wherein do you find they are fundamentally different? A. The fundamental difference is stated by the applicants in their two applications. In the one they claim a reaction of ethylene, oxygen and of steam in the presence of the catalyst. In the other they claim the reaction of ethylene and oxygen in the presence of a catalyst.

Q. And all your testimony has been based upon the opinion that in the original United States patent and the French patents 729 and 739, and their additions, that is, the French patents preceding the filing of the original United States patent, your testimony has been based upon the opinion that in all these ethylene, oxygen and water, that is, C_2H_4, O_2 and H_2O have been made mandatory as reactants in the process? A. That is what the specifications teach.

Q. And likewise all you have had to say with respect to the difference of the reissue patent has been premised on your opinion that in that specification and disclosure the chemical compounds of the reactants are solely C_2H_4 and O_2? A. Yes, sir.

Q. Well, referring to the process of the reissue and referring to the reaction zone, is it not true that in that case there are present in the gas mixture in the reaction zone in the presence of the silver catalyst and with the temperature between 150 and 400 degrees, C_2H_4, O_2 and H_2O?

The Witness: In the reissue you ask for?

Mr. Watson: Yes.

A. Yes.

A. In the Reissue, did you ask?

Q. Yes. A. Yes.

Q. Likewise in the original, is it not true in the reaction zone there are the substances C_2H_4, O_2 and H_2O? A. Yes.

Q. Are the original and reissue patents significantly different in your opinion in the specification of the use of silver as a catalyst in this process? A. There is only one point there where there is a significant difference. In the one case silver is specified in the examples as in the form of powder and in the form of gauze and in the reissue it is specified as finely divided silver.

Q. Is it not your opinion as a skilled chemist familiar with catalytic surfaces that the surface of an activated silver gauze is properly described as silver in finely divided form? A. I would describe silver in finely divided form as any form of silver which was produced by chemical reaction.

Q. I will ask you that same question, may we not properly refer to the active surface of silver gauze as silver in finely divided form? A. After activation?

Q. Yes. A. Yes.

Q. In other words, you did not mean to imply that the reissue patent makes any material departure from the original in that the reissue excludes silver gauze? A. No.

Q. You do not think it does exclude silver gauze? A. No.

Q. You find the original and the reissue patents alike in specifying that the reaction occurs at a controlled temperature between 150 and 400 degrees Centigrade? A. Yes.

Q. And alike in that ethylene oxide is produced? A. Yes.

Q. And alike in that ethylene oxide is produced without aldehydes? A. Yes.

Q. Well, now, coming back for a moment to your answers to my immediately prior question, let us consider the original and reissue patent disclosures of their processes with respect to the conditions present and occurring in the reaction zone which, of course, is the only place the process occurs and the only place that this suit deals with. You were told, I think, how the silver catalyst was made in the demonstration in South Charleston? A. Yes.

Q. And, of course, that catalyst produced ethylene oxide there. Now, suppose we take a silver surface catalyst thus prepared on carborundum instead of filtros, which you were not familiar with, and pass ethylene, C_2H_4, and air or O_2 and the constituents of air in which the O_2 is present, over that catalyst at this temperature of 150 to 400 degrees, will you get ethylene oxide and no aldehydes? A. I am told that you got ethylene oxide by that experiment.

Q. Except in that demonstration we used filtros and in my question I am specifying carborundum? A. In view of my conversation with Mr. Carter and the testimony he has given, I would suspect that you might get it by that experiment.

Q. That would make no difference? A. I don't know of any experiment where the particular method of incorporation on the alundum has been used, this particular method of incorporating the silver on the alundum.

Q. We understand in the demonstration apparatus filtros was used. My question was, putting it on carborundum would we always get ethylene oxide without aldehydes? A. I would expect you to.

Q. In that case, there was present in the reaction zone C_2H_4, ethylene, O_2, molecular oxygen and H_2O, were there not? A. Yes.

Q. Do you know whether there was water vapor present in the entering gas mixture before it reached the reaction zone? A. In what particular experiment and where?

Q. In the demonstration at South Charleston? A. I presume that, I am speaking from hearsay, of course.

Q. I was wondering, you may. A. I am speaking from hearsay. I understand that ethylene and air were led through two tubes and down through the catalyst.

Q. And that the air contained water vapor? A. Yes.

Q. In your opinion, would the results in the production of ethylene oxide have been substantially changed, other conditions remaining substantially alike, if the entering mixture had been dried? A. I think that there

might have been changes in the composition of the exit, yes.

Q. Do you still think there would have been ethylene oxide produced without aldehydes? A. I think that is quite probable.

Q. So that in your opinion there is a concrete example where you may prepare or where one may prepare an active surface silver catalyst on an inert support, pass ethylene and air over it and get ethylene oxide without aldehydes, whether or not the entering gas mixture was dried, is that right? A. Yes.

Q. And in both of those cases there was H_2O, water, in the reaction zone? A. Yes.

Q. So that in both of those cases, in the reaction zone there occurs a direct chemical combination of oxygen with ethylene in the proportions of one atom of oxygen to one molecule of ethylene? A. Yes.

Q. And that occurred in the presence of a catalyst? A. Yes.

Q. And in the presence of water vapor? A. Yes.

Q. You have had practical experience in observing the transition of industrial processes from the laboratory to large commercial plants? A. A little.

Q. You are modest? A. No, that is the truth.

Q. It is common in such transitions that a great deal of engineering as distinct from research is involved, is that not true? A. Yes.

Q. Now, you spoke as a second factor of variance between the reissue and the original, the reissue's recitation in claim 9 of a heat absorbing diluent, do you recall that? A. Yes.

Q. The substances referred to by that term "heat absorbing diluents" include nitrogen and carbon dioxide in the reissue? A. Nitrogen, carbon dioxide, water and hydrogen.

Q. Well, I am glad you bring that up. You referred in your direct examination to the specification of water

in the reissue as a heat absorbing diluent. You don't mean to give the Court the impression that a chemist would fail to know that the hydrogen when added, if desired, as stated, would burn to water? A. I would say it is common knowledge to know that hydrogen would so burn to water and therefore would not function as a heat absorbing diluent.

Q. I agree with you and I have read from the reissue patent that hydrogen was included as such, but in any event we are in agreement that a chemist reading the patent would know that hydrogen when added, if added, produced heat? A. And produced water.

Q. And heat? A. Yes.

Q. Well, now, in the original patent, on the question of variance, which is all we are at the moment concerned with, is it not true that nitrogen was contemplated? A. Contemplated in what?

Q. In the disclosure of the original patent, as one ingredient possibly of the entering gas mixture? A. Yes, it says quite definitely that the oxygen can be supplied in the form of air.

Q. In following the original disclosure in that respect, a chemist would know that the nitrogen was a heat absorbing diluent in the process, is that not right? A. Yes.

Q. And that applies also to carbon dioxide, which is also disclosed as permissive in the original, is it not? A. As a heat absorbing diluent?

Q. As a diluting ingredient of the entering gases? A. Disclosed as a possible ingredient of the reacting gases.

Q. Of the entering gases? A. Of the entering gases.

Q. Of the entering gas mixture, let's put it that way, and when so employed and if so employed under the permission, a chemist would know that the carbon dioxide in the entering gas mixture would act as a heat absorbing diluent, is that true? A. He would if he thought about it, yes.

Q. Then my notes indicate that your next topic was in claim 8, the specification of an active surface catalyst of material having the catalytic characteristics of silver and so forth. You stated, I believe, that that was a very broad, indeed, an extraordinaryly broad specification? A. Yes.

Q. Do you know any catalyst in this imaginary area of extraordinary scope which actually would fall within that specification except silver or the others mentioned? A. Osmium if it gives the results.

Q. I am asking you, Doctor Taylor, not a speculation, but so far as you know, is silver the only one that falls in that definition? A. At the present moment? Known at the present moment, do you mean?

Q. I presume you were—well, yes. A. Only silver is known at the present moment as far as I know.

Q. Silver or the other elements mentioned in the reissue patent, so then your criticism of the extraordinary scope of that language is a criticism, as I understand it, of an academic speculative possibility in the future as far as anything up to date is concerned, is that right? A. It is not an academic business. It is a very serious hindrance to future inventors.

Q. Let's limit ourselves for the moment as a practical matter up to this date, it has been no handicap, is that right? A. I don't know of anything that has been handicapped.

Q. Up to this date, as far as you know, no one has found anything but silver that will meet this specification? A. As far as I know, yes.

Q. When you speak of the factor of correlating in the claims, it is common in gas phase catalytic processes, is it not, to adjust rates of flow and proportions of the entering mixture to the particular degree of temperature involved? That is a normal part of the operation in establishing conditions which are to be maintained, is it not? I am speaking practically now, practical operation?

The Witness: One relates the velocity of conduct of gases over the catalyst in terms of the amount of cata-

lysts, the velocity of reaction, the temperature at which it takes place, the concentration of diluent, and so on, yes.

Q. That is the normal thing done always by one skilled in the art? A. Yes.

Q. And a most important requirement of it is that he shall avoid extravagant extremes in any direction, is that right? A. I presume he would do that.

Q. In response to a question of the Court, on the extent of the chemical difference between the processes of the original patent, and the reissue, as you expressed it on direct, you referred in support of your opinion to the illustration that it was evident from the literature that prior workers had not succeeded in obtaining ethylene oxide from ethylene and air, is that what you said, or is that correct? A. Yes.

Q. To whom did you refer in the literature on that? A. I referred to Willstatter and to Reyerson.

Q. You are still willing to stand or fall on the soundness of your opinions expressed in your direct on whether water makes what you have called the process of the original patent and what you have called the process of the reissue patent, chemically different? A. The French company tells me that these are two different processes, and the third French patent constitutes a new invention.

Q. All right, suppose you had never heard of the French patent, it had never been issued and no publication of the question, and suppose you didn't know anything about the earlier French patent, suppose you take just the original United States patent as granted and the reissued United States patent as granted; in your opinion are the processes of those two chemically different? A. The processes of those two are chemically different if you regard the system as a whole.

Q. Well, we have already agreed, I think, that we can confine our consideration to the ambit of the reaction zone. Thus confining our consideration, is it your opinion that those two processes are chemically different? A. Chemically different in that in the one there is a large excess of water and in the other case a very small amount of water such as produced by the reaction.

Q. There is an excess of water in both cases? A. No.

Q: Are there in both cases— A. In one case the water is added, and in the other case water is an incidental product of the reaction.

Q. And in both cases the water comes out in the exit gases? A. Yes, sir.

Q. So that in both cases there are in the reaction zone among other things C_2H_4, O_2, H_2O and C_2H_4O? A. Yes, sir. * * * [580-596].

Q. In your direct examination—I will just ask you one question here about that—you referred to activated alumina as an inert support in a test of this process which at one time you contemplated doing. A. Yes.

Q. Doesn't the literature as early as 1931 tell you that activated alumina is not an inert carrier in this process? A. An inert carrier for what?

Q. Is not an inert support, suitable— A. For what?

Q. Suitable to use as a support for the deposit of metal, silver, for the purposes of passing ethylene and air over it to obtain ethylene oxide. A. To my knowledge the literature doesn't say so.

Q. Now, on claims 8 and 9, you mean to express the opinion that if one added a small quantity of water in the entering gas mixture one would thereby cease to do what is specified within those claims 8 and 9? A. I think that if one used a mixture of ethylene and oxygen and added water you will come within the specification of the original specification. If you do not add water you would come within the patent issued to the French company, the third French patent, which covers the interaction of ethylene and oxygen in the absence of water.

Q. You have not answered the question, which I will have to repeat: Do you think that one passing a mixture of ethylene and air and some moisture over silver at a temperature of 150 to 400 degrees, to produce ethylene oxide, would be doing something excluded by the language of claims 8 and 9 of the reissue patent? A. If the water, if the moisture were deliberately added, yes.

Q. You think he would be doing something excluded by the language of those claims? A. Yes.

Q. Suppose the mixture contained 1½ per cent water, do you think that would be outside the claim? A. If that was the content of the air that would be all right.

Q. If you used dry air, but added 1½ per cent so that you had the same entire mixture, do you think that would be all right? A. You would first dry the air and then wet it again?

Q. That's right, and having thus wet it so that you still have 1½ per cent water vapor, and sending it over the same silver catalyst at the same temperature, do you think you would then be— A. You would then be really using a mixture of ethylene and air.

Q. Well, answer the question: When you are doing that do you think that you would be doing something outside the specification of claims 8 and 9 of the reissue patent? A. I think so because you would be adding water.

Q. So that you think the question of variance here boils down to this narrow compass: that if you pass a mixture of ethylene and air and 1½ per cent water vapor over a silver catalyst at a temperature of 150 to 400 degrees to produce ethylene oxide without substantial aldehyde formation, the question of whether what you are doing is within the disclosure of the first patent, as you have expressed your opinion, or the disclosure of the reissue patent, as you have expressed your opinion, is decisively dependent on whether that 1½ per cent water was water vapor normally present in the air with which you mix your ethylene, or whether that same 1½ per cent water vapor was deliberately added to dry air which you then mixed with your ethylene? Is that your position? A. My position is that if you use a mixture of ethylene and air you would be following the procedure described in the third French patent, and I would suspect that anything equivalent to that procedure would also come within the provisions of the third French patent.

Q. Well, now, we will make a little faster progress if we confine ourselves to the original United States and the reissue United States—

The Court: Now, wait, aren't you just—I think I understand what the witness has said; he has been saying this over and over again, and I think it is pretty clear to me. He has been adopting really the conditions of the French patent, and as his reasons for distinguishing it he says that the patentee, the French patentee, in the beginning of Patent 771650, says, "The applicant has improved his process for bringing into play a catalyst suitable for obtaining a specific reaction which gives ethylene oxide as the oxidation product, this improved process marked a considerable step forward in the technique of the production of ethylene oxide by the direct oxidation of ethylene, but the necessity of vaporizing large amounts of water required an expenditure of calories which, obviously, contributes its share to the production cost of the ethylene oxide obtained."

Now, I understand the present witness says that that describes the original United States patent.

Then, the application goes on, "The present invention remedies this drawback. It has as its object a process for preparing ethylene oxide by the direct oxidation of ethylene without water vapor and with no explosion hazards."

I understand the present witness to say that he interprets the reissue patent as expressing exactly the last thing that I have read, and that the fact that the water is added initially gives the distinguishing feature.

Am I interpreting you correctly?

The Witness: Yes.

Mr. Watson: Well, I have boiled that down to the question where the witness is expressing an opinion on the amount of water vapor: 1½ per cent water vapor in one case he says constitutes the process of one patent, and that same amount in the other case may constitute the other process.

The Court: No, I did not so understand.

The Witness: Your Honor, you pointed out that the first patent, as I interpret it, corresponds to the use of large quantities of water, and that the reissue patent

covers the third French patent, which deals with a mixture of ethylene and air with water absent. Now, that is what I wish my interpretation of these two patents to stand on * * * [596-603].

* * * The Court: Now, do you want to say anything more, Doctor?

The Witness: I claim that the essential distinction between the original issue and the reissue is well defined by the parallel French patents, and that the nature of the reissue is determined by the discovery that was made by the French people in 1933, to the effect that it was not necessary, as in the original specification, to add large quantities of water; it was possible to operate the process with ethylene and air, and the amounts of water vapor that would normally go with such air.

Q. (By Mr. Watson) Well, now, you certainly do not want to give the impression, do you, Dr. Taylor, that if these later French-British patents were out of existence, you would have been unable to discover any difference between the original and the reissue of the Lefort patents? A. I should have discovered that in the reissue there was something that was not in the original.

Q. And your conclusion would not have been other than you have already expressed it, that the difference made the processes entirely divergent chemically? A. Yes, in this sense, that in the one case you are injecting water with a pump, or with a live steam line; and in the other case you are allowing it to pick up the amount of water vapor that it would normally do in the course of technical operations.

Q. Now, you referred at some length many times to the French, the late French patent 771650, that had a corresponding British which was not sealed. It is not your position that the British as a disclosure is any different from the French, is it? A. It should not be, because they both have the same convention date.

The Court: I think the witness said they were the same yesterday.

Q. (By Mr. Watson) Referring to the British for a moment, 431966, according to your direct examination,

which I can not put my finger on at the moment, but I understood you to say that this disclosure of the British document, as well as of the corresponding French, is epitomized in their respective statements, that the operation thereby contemplated is one of producing ethylene oxide by the catalytic oxidation of ethylene, in the presence of an inert gas, and in the absence of water; is that right? A. It says, "It is differentiated from the previous proposals by the use of a substantially dry reacting mixture." That is what the British patent teaches.

Q. And in line 64 it says, or 65 to 70, it says: "Thus, according to the present invention, ethylene oxide is produced by the catalytic oxidation of the ethylene, in the presence of inert gases, and in the absence of water." A. Yes.

Q. And that epitomizes your understanding— A. Yes.

Q. —and the radical differentiation of this document from the earlier— A. Yes.

Q. —United States and French Lefort patents; is that right? A. And in that connection I would like to observe that 1½ per cent of water vapor, since it is present in air, could be regarded as a substantially dry mixture, no matter * * * [604-607].

* * * Q. (By Mr. Watson) One more thing: I think you referred in your direct to the Willstatter article. Was I correct in understanding you to say that Willstatter drew the conclusion that metal catalysts were utterly worthless for any purpose except oxidizing ethylene to carbon dioxide and water. A. He stated that they were utterly useless for the oxidation of ethylene to form formaldehyde.

Q. And so far as his article discloses, they were also utterly worthless to produce ethylene oxide; is that correct? A. There was no evidence in the article about that * * * [608].

* * * * * *

REDIRECT EXAMINATION.

By Mr. Edmonds:

Q. Dr. Taylor, you have examined the records of many tests of catalytic operations on the oxidation of ethylene, have you not? A. Yes, sir.

Q. Many hundreds of them? A. Yes, sir.

Q. If you yourself had performed all of the tests covered by the records that you have examined, would the time that it required run into years? A. It would have run into many years.

Q. Has anything that was said on cross here this morning caused you to want to alter anything you said on direct on the subject of silica gel, the use of silica gel as a support for a catalyst? A. I would like to make a general statement about the definition of an inert support. Silica gel, for example, is an active catalyst for the dehydration of various substances. When it is used as a material for dehydrogenation to take the hydrogen out, it is an inert material, certainly in the range specified in this particular thing. So far as I know, in oxidation processes, and certainly in the experiments conducted by Reyerson, silica gel is stated quite definitely in that paper to be an inert material in causing the oxidation of ethylene to carbon dioxide and water. Therefore, from the standpoint of an oxidation support material, support material for an oxidation catalyst, I would regard from all the evidence available to me that silica gel was an inert catalyst material, a catalyst support material.

Q. Now, I wanted to ask you this: Are you familiar with the commercial use of silver as a catalyst in a catalytic operation? A. Yes.

Q. What particular one is that? A. The conversion of methyl alcohol to formaldehyde.

Q. What is the form of silver catalyst used? A. So far as I know, it is silver gauze.

Q. And what is the form of the surface of the gauze used in that operation? A. The gauze is originally put in, is just originally put into the apparatus, and the reaction is started.

Q. It is what we might call an unactivated gauze? A. Yes.

Q. As distinguished from the activated gauze you spoke of? A. Yes.

Q. Now, one other matter I want to ask you: It has been stated in certain pretrial proceedings in this suit that there are various silver catalysts that are not effective for the purpose of oxidation of ethylene, and that there are various silver catalysts that are effective for this oxidation, in a part only of the temperature range specified in the patent. Now, I want to ask you if you agree with that? A. Yes, sir * * * [614-617].

* * * * * * *

Recross Examination.

By Mr. Watson:

Q. What temperature was used in this last catalytic process you referred to, with silver, methyl alcohol, formaldehyde? A. Well, it is hot. I don't know the actual temperature.

Q. You don't know the temperature? A. It is four or five or six hundred, I suppose.

Q. Now, the only basis for your views on the silica gel being an inert carrier, that you have just expressed, are those in the Reyerson article? A. Yes, sir * * * [618].

* * * * * * *

Thereupon——

HUGH STOTT TAYLOR (recalled), a witness heretofore produced and sworn, was recalled by the defendant, examined and testified as follows:

The Court: * * * [1155].

* * * Professor Taylor, in your original examination, as I recall it, you were very positive in your views that you thought the second or reissued American patent reflected the third French and British patents?

A. Yes.

Q. And while at that time you did not know whether or not the person that drew the claims for the reissued patent was actually relying upon those foreign patents, you pointed out it was rather significant that the language seemed to be almost parallel and almost synonymous and almost identical. A. Yes.

The Court: And then you said, if I recall it, you considered those later French and British patents to be materially different, in that they purported to dispense with the addition of water?

A. Yes, your Honor.

The Court: And that, therefore, when, as I understand, you found the same process described in the reissued American patent you reached what would be the necessary logical conclusion, from your other findings: that the reissue was a departure from the original American patent in that the addition of water was no longer made material.

Now, you have since heard the other witnesses who have told about that, first Dr. Frazer said as to the addition of the water he did not think there was any material difference between the two processes. Has anything been stated to alter your original views?

A. No, I am completely unregenerate, your Honor. I would go farther than your Honor's statement that you just made, in this direction: that I would say that in my mind the first and second French patents and the United States equivalent, offer a process involving ethylene, air, and a large quantity of water, not an addition from zero to 4 per cent, such as Professor Frazer discussed yesterday afternoon. From that point of view I am quite unimpressed with the experiments that Professor Lamb conducted. Professor Lamb, in my view, investigated the interaction of ethylene and air on a silver catalyst, whereas it is my view that the first United States patent and the corresponding first and second French patents and the British equivalents call for the reaction of ethylene, oxygen and water, and no better proof of that that I can see can be adduced than the actual language of Example 1 of the original U. S. patent, where he says at page 2, column one, lines 20 and 21, "The reaction will take place in this tube between ethylene, the oxygen of air, and water". Now, professor Lamb has really investigated the reaction between ethylene and the oxygen of the air with a little amount of water which he says got into the reaction system by accident because he thought there might be a little alkali in the air

coming in and so to take it out he actually put in a little wash bottle containing sulphuric acid to simultaneously introduce a small amount of water. Now, your Honor, there has already been offered in evidence in this case the series of experiments conducted by Mr. DeJong of the Shell Laboratories in Emeryville, California, which have a very direct bearing on the quantity of water that was in the minds of the French company in about 1933 since these experiments were inspired by contact between the—— * * * [1155-1159].

* * * The Witness: Your Honor, Mr. DeJong testified these experiments were based on report No. 5205, I think it is, which recorded the contact between the Royal Dutch Shell and the Societe Francaise de Catalyse Generalisee. Now, in these experiments as much as 60% of water was actually the normal steam content of the reacting mixtures and with that in view I would like once more to refer to this French patent No. 3, to call your attention to what the nature of the change was. Let us assume in analyzing that third French patent that it was the state of the art as understood by the French company that the reaction was between ethylene and air and about sixty to seventy to eighty per cent. of steam. What is the nature of the substitution that they propose?

The Court: Which patent are you referring to?

The Witness: I am referring to the third French patent No. 771650, the first paragraph says that it is now "the direct oxidation of ethylene in contact with pure oxygen or air." The second paragraph states that steam has been used since 1904 for purposes of avoiding explosion hazards, but that aldehydes were produced. The third paragraph says the applicant improved this process using steam and he is undoubtedly referring to his first and second French patent because he now uses a catalyst to produce a satisfactory reaction giving not aldehydes but ethylene oxide as an oxidation product. He then says or points out the drawback of that, he says "the necessity of vaporizing large amounts of water"—now, if it were a question of from zero to 1, 2, 3% of water, it would be no question of vaporizing large amounts of water. Professor Lamb had no difficulty in vaporizing such amounts of water in the experiment which he car-

ried out. He just put the water in his gas line and thereby introduced a small amount of water. It says while that large amount of water constitutes a drawback, he says it requires quantities of heat, calories, "which obviously contributes its share to the production cost of the ethylene oxide obtained. The present invention remedies this drawback. It has as its object a process for preparing ethylene oxide by the direct oxidation of ethylene without water vapor and with no explosion hazards." Now, how does it do that? I think it is significant to point out that it does that by the substitution of diluent gas and it is quite specific as to the quantity of diluent gas that it substitutes. Actually the example that it cites is a mixture made up—and I now read from the third page, the middle of the third page of this specification "A mixture is made up containing for example 66% CO_2, 3.4% ethylene, 6.3% oxygen, and 24% nitrogen." In other words, the mixture of air and ethylene and CO_2, how much CO_2, 60% CO_2, to replace the 60% of steam which we have definite evidence in this Court was what the practice of the French company was as indicated by the information that they yielded, on the basis of which Mr. DeJong's experiments were carried out.

The Court: Well, now, aren't we giving too much emphasis to the French patent? Take the Reissue patent itself on lines 39, 40 and 41. It certainly provides for some water or carbon dioxide in addition to that volume which can be assumed to be in the mixture; in other words, there we have that permission granted in the specification.

The Witness: But in reply to that, I would then just go back to the very beginning of the two specifications. The first specification begins: "This invention has for object a process for the production of ethylene oxide which mainly consists in subjecting ethylene to the simultaneous action of the oxygen of air and of water, in presence of a catalyst," and if need be in order to get some more water, hydrogen, and the Reissue says, "This invention provides a specific and novel process for making ethylene oxide. It consists essentially in causing ethylene to combine directly with molecular oxygen at temperatures of about 150 to about 400 degrees in the presence

of a surface catalyst which favors the oxidation of ethylene to ethylene oxide under these conditions," and then, "the process can be carried out at atmospheric pressure and it may also be conducted at pressures above or below atmospheric pressure." Nothing about water.

The Court: As a practical matter though, we have here a man who provided first for adding some water in indefinite amounts, depending on how he wants to do it, then we have the same man saying that he wants to broaden the specification and he says you can add some water if you want to and he still talks about this reaction taking place in the presence of water. Now, no one in this case has produced any experiment or the results of any experiment or any laboratory work which indicates that you can successfully complete this process and get the ethylene oxide if the process is kept, if the reaction is kept completely dry. In other words, Doctor Lamb was given—and by the way, in your reference to what he said he did, we must bear in mind that he was only given the one patent.

The Witness: Yes, the first patent. That was the one I quoted from.

The Court: Am I correct in that?

Mr. Watson: That is correct, only the original United States Patent.

The Witness: I quoted from that as to what the reaction was.

By the Court:

Q. Yes. Now, isn't it a fact that no one has demonstrated in this case that you can successfully make this with complete dryness? A. Yes, nobody.

Q. There is no evidence of that? A. No.

Q. If you couple with that the fact that you start off with a man saying you must have some water and you have evidence that if you have some water, if you add a little, you get it from the air or no matter how you have it, it is there, you have successful operation, and that man says "I will still allow water to be used, you can

add some if you want to or not." As a practical chemical matter, why would we say that that man is departing from his original invention when he simply refers to the fact that water appears to be less necessary, although we have no evidence whatsoever here, though it may come out to some extent. That is the point I don't understand as a practical matter. You have the first patent saying "Put some water in." The second patent says, "You can put some water in if you want," and all of the evidence in this case indicates that the successful operations have been made under conditions where there was some water. Now, why should the Court be asked to say that the man is departing from his original invention when he simply says I think you do not need to use it, you don't really need to add water like I said you did in my first patent. A. I don't know legally whether I am right, but my point of view is—and I think I expressed it in my direct testimony—that what has happened has happened and so he has obtained a 1931 date for a 1933 invention * * * [1160-1166].

* * * Mr. Edmonds: Then, may I ask Professor Taylor a question or two with reference to the excluded exhibits, this being for the record as to excluded testimony.

Q. (By Mr. Edmonds) All I want to ask you is whether or not you have examined Exhibits 66 and 67? And if so, whether or not those exhibits corroborate what you have stated about the papers that Mr. DeJong examined with respect to the amount of moisture in the air admitted to the reaction chamber, as advocated by the French company in the winter of 1933-4.

The Court: Are these the excluded exhibits?

Mr. Watson: These are the excluded exhibits.

The Court: Well, he can not testify to those. They have been excluded.

Mr. Edmonds: I ask your Honor to record on the record this statement by him, under Rule 43, as testimony with reference to an excluded exhibit * * * [1170].

* * * A. I have examined these exhibits, and read them through.

Q. And will you answer the rest of the question? Do they corroborate, do they give you the same opinion as what you said was contained in the other exhibits * * * [1171]?

* * * The Witness: I have read both of those exhibits, and I think that they do corroborate the evidence that has been given by Mr. DeJong. * * * [1172].

* * * Cross Examination.

By Mr. Watson:

Q. Dr. Taylor, you recall the language of Resume 5 of the first French Patent? A. Yes, sir.

Q. That states a chemical fact, doesn't it? A. Yes, sir.

Q. And the facts of chemistry have not changed since 1931, have they? A. No, sir * * * [1173].

* * * Redirect Examination.

By Mr. Edmonds:

Q. And do you regard that statement as contradicted by later statements? A. I certainly do regard it as contradicted by later statements. And I am of the opinion that it applies to a process which is not in issue, namely, the catalytic action of ethylene, air and water, in the presence of antimony, arsenic, and bismuth * * * [1173-1174].

* * * * * *

Thereupon——

HUGH STOTT TAYLOR (recalled), a witness heretofore produced and sworn, was again recalled by the defendant, examined and testified as follows:

Direct Examination.

By Mr. Edmonds:

Q. Doctor Taylor, will you address yourself to the state of the knowledge on this subject as it existed

prior to March of 1931 and whether or not you find in the published literature prior to that date the equivalent of what you find to be disclosed in the Reissue patent in suit? A. I think I can do that. I think I can do that very briefly. The discovery or the suggestion of the partial oxidation of ethylene to ethylene oxide is an old concept. It dates from 1862, when Wurtz suggested and tried it * * * [1194-1195].

* * * The Court: When you say suggested——

The Witness: He actually tried to do it.

By the Court:

Q. He did not do it? A. No * * * [1195-1196].

* * * The Witness: Following that I would come down to 1905 and there I would cite British patent 21941 of 1905 to Doctor Walter of Germany, in which he discusses the transformation of organic substances by partial combustion, and in which in instance 4 on page 3 of the patent he discusses the oxidation of ethylene with oxygen by passing these gases through a tube heated to 400 degrees and in the presence of catalysts as specified on page 4. "The following may be employed as such contact substances: The metals platinum, iridium, palladium, silver, uranium, vanadium, iron, cobalt, nickel, cerium, thorium," and so forth.

Q. What is the date of that? A. 1905.

Q. Is that the issuance or the application? A. That was the issuance, Anno Domini 1905, but the claim for the patent was the 27th of October, 1904.

Q. Well, now, can you summarize again, do you claim that is directly in anticipation? A. I claim that is evidence that people had attempted to produce partial oxidation products of ethylene and oxygen, of which Wurtz in 1862 had said ethylene oxide was one.

Q. Could you follow, could you take the teachings of that patent and make ethylene oxide? A. I could now, certainly.

Q. And it was not done then? A. No, he was not trying to make ethylene oxide.

Q. What was he trying to make? A. Formaldehyde.

Mr. Watson: And he made it?

The Witness: And he made it.

By the Court:

Q. You are not claiming, are you, that that is a direct anticipation? You are giving me that as a second step in the evolution? A. I am giving it as evidence that the process of passing ethylene and air over a catalyst to produce partially oxidized materials was common knowledge in 1905.

Q. But no one has yet found out what they got by doing it? A. Yes, they found out they got formaldehyde and they also got carbon dioxide and water.

Q. They hadn't found out yet what we are talking about? A. Not yet. Then I jump over to 1921 and I find there an article by Willstatter and Bommer, which is also concerned with the preparation of formaldehyde from ethylene.

Q. What is that, what date? A. The paper is published in——

Q. 1924, did you say? A. 1921, volume 422, page 36, 1921.

Mr. Fairbank: That was cited by the patent office against Lefort, wasn't it?

The Witness: That was one of the patents cited against Lefort by the patent office. Now, in that particular article it is stated that "For the oxidation of ethylene to formaldehyde, accelerators, of all kinds, for example metals such as silver or copper, as well as metal oxides" are useless. He points out that the reaction starts at 130 degrees with the formation of carbon dioxide, and at about 200 degrees centigrade the oxygen is used up. With copper and silver no formaldehyde is formed and even with an excess of ethylene no carbon monoxide appears. So he points out that with copper there is considerable reaction at 250°C, and at 400 centigrade, with a mixture of 80% ethylene and 20% oxygen, half of the oxygen was con-

sumed, forming carbon dioxide. In other words, he showed that on these catalysts carbon dioxide was formed from ethylene and oxygen. Now, I would skip to 1928 and there cite an article by Reyerson and Swearingen that has already been discussed in this case.

The Court: By whom?

The Witness: Professor Reyerson and Swearingen, an article which appeared in the Journal of the American Chemical Society Volume 50, page 2872, 1928, and in that article Reyerson passes oxygen and ethylene over silver catalysts such as silver on silica gel, and he says that he is studying the action of the silver because he suggests on page 2878 that if you were not doing that, the silica gel itself would be an active catalyst. Now, then——

The Court: Do you claim that is a direct anticipation?

The Witness: No, it is not direct anticipation because Reyerson got carbon dioxide and water. Now, the points I wish to raise with regard to the prior art are two. With reference to that background as I have given it to you, what was disclosed in the Lefort patent that Willstatter and Bommer and Reyerson had not already done? They had passed ethylene and oxygen over a silver catalyst and had not observed any ethylene oxide. What did the patent teach which these men had not done? I cannot find anything that the patent teaches that these men had not done, and, if that is true, I would suggest that the patent therefore is insufficient in its disclosure by reason of that prior art. There is another alternative. The other alternative is that you can produce ethylene oxide with silver and that the thing for Reyerson to have done was to have chosen another catalyst, another silver catalyst. If that is the solution of the problem, then there was no act of invention, on the part of the inventor. If all that it was necessary to do was to take Reyerson's experiment and use another catalyst, such as the one that Benton and Elgin had suggested in the literature prior to that time, doing exactly what he did in the region from 200 to 300, which is the region that Reyerson explored, and

using another catalyst get the result, then it seems to me there is no act of invention disclosed by Lefort in his application. That is all I have to say with regard to that aspect of the matter. It leaves us in the position where there do not appear to be any adequate directions in the patent specification over and above what those gentlemen have done before to produce ethylene oxide and, if so, the patent is inadequate in its disclosure, and it does not represent any act of invention. Then, I would think that very considerable weight ought to be given to two prior patents, two prior United States patents, the McElroy patent number 1253617, filed in 1912, renewed in March, 1916, and patented in January, 1918, and another patent to McElroy, No. 1308797, application filed on June 26, 1917, patented July 8th, 1919. Now, your Honor, I don't think that I can explain this particular patent any better than Mr. McElroy did himself and I would therefore like to read you about two paragraphs of the appropriate specification and leave the matter in that position without comment. Mr. McElroy says——

The Court: Which patent are you reading from?

The Witness: 1253617. Similar passages will be found in the second patent, but patent 1253617, at page 1, column 1, line 24, states "There are various oxygen-containing or oxidized derivatives of ethylene, such as glycol, the chlorhydrin, glycol esters, glycol ethers, ethylene oxid, etc., having properties which would render them useful in various arts if such derivatives could be produced by a method sufficiently simple, cheap and ready to make them commercially available. At present however, these bodies are not available for technical purposes being merely laboratory curiosities, made when wanted for scientific purposes by indirect, cumbrous and wasteful methods."

I now turn to the paragraph in that same column, beginning at line 50 "It is an object of the present invention to obtain these potentially valuable oxidized bodies from ethylene and other olefinic gases by a direct limited oxidation under controlled conditions.

Ethylene which is typical of the other olefinic gases is a readily oxidizable substance but being endothermi-

cally constituted, oxidation is attended with the liberation of much energy and is apt to be too far going, while the direct products of its limited oxidation, ethylene oxid, glycol and chlorhydrin are themselves also readily oxidizable. Ethylene oxid, which is the first product of oxidation, is particularly sensitive; glycol is more resistive."

"I have found however that under suitable conditions the oxidation of ethylene can be limited and regulated to the desired degree and that such a limited oxidation of the ethylene itself, is, so to speak, preferential over the further oxidation of these proximate oxidation products; that is, so long as unattacked ethylene remains in the sphere of reaction the oxidation merely goes to the first stage."

May I call attention to line 62 in this same column "Ethylene oxid, which is the first product of oxidation, is particularly sensitive; glycol is more resistive.

"In the present invention therefore conditions are so controlled as to restrain the violence of reaction, the heat of reaction being absorbed or removed as fast as evolved so as to maintain a predetermined temperature range; and an excess of ethylene is maintained in the sphere of reaction throughout the course of such reaction. While other methods of temperature control may be, and usefully are, employed dilution of the reacting bodies is desirable as this also aids in controlling the progress of the reaction. As stated, ethylene is endothermic and tends to enter into reaction with accelerating velocity; and dilution is useful in damping down the violence of the action."

Now, comes the point which I wish specifically to call attention to. Beginning with line 93 "Dilution is useful in the limited oxidation of ethylene in the gaseous state," and here follow two methods of doing that, first, "By chlorin and steam, steam being best present in ample amount." That is one method of oxidizing ethylene by chlorin and steam. It does not come into this picture at all. The second method, I quote "And by oxygen in the presence or absence of catalytics such as platinum black,

labile oxids, nitrous vapors, etc." This is the third clause of this particular paragraph. He then points out another method whereby dilution may be accomplished and he writes "And in the treatment of ethylene dissolved in various liquids; advantageously an aqueous liquid," and with regard to this third method of operation he cites on page 2, beginning line 34 and ending with line 45 a description of the introduction of ethylene itself into a liquid in which is present adsorptive material such as charcoal, coke, bone-black, platinum black, etc.," and he adds on line 40 of page two, "Such bodies may, and usually do, superadd a useful catalytic effect in aiding oxidation. For example, ethylene and air may be supplied to a hot liquid holding platinum black or colloidal palladium or the like in suspension."

I think that disclosure ought to be considered in connection with the third patent of Lefort.

The Court: Well, now, in what claims of this patent does he speak about the catalytic process?

The Witness: He has a broader claim than that, your Honor. Claim 1 is "the process of preparing useful products which comprises submitting an unsaturated gaseous hydrocarbon to limited oxidation, such hydrocarbon being maintained in excess in the sphere of reaction during such oxidation."

The Court: Was this cited to the Patent Office?

The Witness: No.

The Court: Well, are you claiming this is a direct anticipation?

The Witness: That is how I would look at it, your Honor.

Q. (By Mr. Edmonds) Is there any other claim of that patent to which you think reference might be made in connection with this matter? A. Yes, claim 31: "In the manufacture of useful products, the process which comprises submitting an unsaturated hydrocarbon to limited oxidation, and during said oxidation and while supplying hydrocarbon to the reaction chamber continuously maintaining therein oxidizing conditions."

Q. Now, most of the other claims of that particular patent are limited to this other form that you spoke of, namely, the electrolytic one? A. Yes, sir.

Q. Now, will you turn to the other patent, the other of the two McElroy patents, and state what the fact is about that as to its disclosure, and refer to any claim there which is directed specifically to the catalytic operation? A. Well, if one reads the first page of United States patent No. 1308797, one finds similar material to that which I have read at length in the first patent. And, therefore, I do not think it is desirable to repeat that reading.

I then turn to page 6 of that patent, and I find in the process of producing oxidation products of the olefines, a step which consists in subjecting the olefine——

The Court: What line are you reading from?

Mr. Edmonds: The sixth page.

The Witness: This is page 6 of the second patent, 1308797.

The Court: The last claim?

The Witness: Yes, sir. "In the process of producing oxidation products of the olefins, the step which consists in subjecting an olefin to the action of an oxidizing agent in the presence of a catalyst while maintaining the olefin in excess."

The Court: What is an olefin?

The Witness: Ethylene is the first of the series of olefins. Olefin is the generic name for a series of gases, of which the first one is ethylene.

The Court: Do you think that is an anticipation?

The Witness: Yes, sir.

The Court: Although there is no mention anywhere of a silver catalyst in this or the preceding patent.

The Witness: There is mention of labile oxides, your Honor.

Q. (By Mr. Edmonds) And what is the significance of that? A. The significance of labile oxides is that it includes silver oxide.

The Court: Do the drawings disclose a catalyst?

The Witness: No, because the patent itself devotes its attention largely to an electrolytic method of producing oxygen.

The Court: What is the difference between 1308797 and 1253617.

The Witness: They are similar in content, but they are drawn with a skill which I think requires more than a chemist to understand the difference.

Q. (By Mr. Edmonds) The difference lies in the claims, does it not? A. Yes, surely; obviously it lies in the claims.

Q. The same disclosure in both? A. You see, one says the process of preparing useful limited oxidation products, and the other says the process of producing glycols.

The Court: These were not cited to the Patent Office?

The Witness: No, sir. May I say a word with regard to the term "labile oxides" suggested as a catalyst? The term "labile oxides," in my view, includes, among other oxides, silver oxide.

Q. (By Mr. Edmonds) And is silver oxide referred to in the specification of the Lefort Reissue? A. Yes, sir.

Q. And was the term labile oxide understood for many years prior to 1931 to specify silver oxide, among other things? A. Yes.

The Court: You mean to include or to——

The Witness: I would include silver oxide among the list of labile oxides. If your Honor pleases, I can give a very definite proof that that is not an ex parte statement on my part.

Q. (By Mr. Edmonds) Well, will you proceed to do that?

The Court: What does labile mean?

The Witness: Labile means it is an oxide which fluctuates between different stages of oxidation.

Q. (By Mr. Edmonds) It may take up and give off some of this oxygen, take up more and give up some? A. Yes.

I cite from an article which I wrote in the Journal of the Franklin Institute in 1922, Volume 194, page 7. "Thus, for example, it may be seen that as catalysts for oxidation processes, oxides are an important class of catalysts."

Mr. Watson: The page?

Mr. Edmonds: Page 7.

The Witness: Page 7. I quote further: "The oxides of well-defined stability are conspicuously absent. The oxides of the alkali metals, to a less extent those of the alkaline earths, definite irreducible oxides such as magnesium oxide and aluminum oxide are not frequently to be found among the oxide catalysts of oxidation. On the other hand, the labile oxides such as those of iron, copper, manganese, silver, vanadium, tungsten, molybdenum, uranium, chromium, cobalt and cerium are frequently to be noted in a systematic study of such oxide catalysts of oxidation."

Mr. Edmonds: Does your Honor want any further elucidation of the portion of the McElroy specification that the witness quoted as, for instance, the reference there to the reaction being too far going, or the reference to the fact that ethylene oxide is the first product of the reaction?

The Court: Well, I would like to ask Prof. Taylor this: Do I understand you to say that just because reference is made to the use of silver as a catalyst in the oxidation of ethylene, although there is no claim in either of these patents, as I understand it, or at least there is no claim in the first one, I understand you to say there is no claim in the second one, for using—no, in the first one—I will take that back—you say in the first one there is no claim for using that method, nevertheless you think this is an anticipation, because the inventor refers to that as a method.

The Witness: The same disclosure is made in patent 1308797, beginning line 75 on the first page, in which claim No. 17 specifically refers to oxidation of ethylene with a catalyst.

The Court: Well, you think that the reference to it in 1253617 is enough, do you?

The Witness: Yes, because there is a claim which is very much broader than the catalytic claim.

The Court: And that is?

The Witness: Claim 1.

The Court: Claim 1.

The Witness: Claim 2, claim 3, claim 31.

The Court: Well, do you claim that you could have taken either one of these patents and successfully, by following their teachings, have made ethylene oxide with a silver catalyst?

The Witness: I think it is abundantly evident to me that I could.

The Court: Well, could you at that time have done it, at the time of these McElroy patents, without the temperature specifications and the other specifications that are contained in the patents in suit?

The Witness: Yes, because he says that, "I must predetermine my temperature range so as to maintain a predetermined temperature range," lines 79 to 81.

Q. (By Mr. Edmonds) To you does that sufficiently specify an elevated temperature? A. Yes.

The Court: Where is that?

The Witness: Because he says——

The Court: What page now are you reading from?

The Witness: I am reading on the first page.

The Court: Of 1380797?

The Witness: I will read from that if you like, sir.

Q. (By Mr. Edmonds) You can refer back.

"It is an object of the present invention to obtain these potentially valuable oxidized bodies from ethylene and other olefinic gases by a direct limited oxidation under controlled conditions. Ethylene which is typical of the other olefinic gases is a readily oxidizable substance, but, being endothermically constituted, oxidation is attended with the liberation of much energy and is apt to be too far going, while the direct products of its limited oxidation, ethylene oxid, glycol and chlorhydrin are themselves also readily oxidizable," indicating that we are dealing with things which go up in temperature unless we check them.

Q. Now, the Court asked you if other conditions were set forth there as fully as in Lefort. Are there any other conditions set forth in Lefort? A. No, sir.

The Court: Let me see, to recapitulate. I understand you to say that you think these two patents do directly anticipate; but you do not think any of the other references are an actual anticipation, because they suggest the process, but do not really disclose it.

The Witness: The other references as far as I have indicated anticipate the interaction, the limited oxidation of ethylene and oxygen in presence of silver catalysts, and I call attention to those to indicate that they suggest the question, Why, what did Lefort teach in his patent that these gentlemen had not already done? And if the answer is that he did not give them sufficient directions over and above what they had done, there was an incomplete disclosure. Or, alternatively, you might say, taking Reyerson's experiments, who passed ethylene and oxygen over a silver catalyst, and got carbon dioxide and water, what should he have done, following his process, to get ethylene oxide? If the suggestion is that by taking another silver catalyst which was known, for example, that of Benton & Elgin, then there is a lack of an act of invention on the part of Lefort.

Q. (By Mr. Edmonds) Let me see if we can put that same thought a little differently. Take any one of these prior art disclosures of the catalytic oxidation of ethylene, producing some substance other than ethylene oxide, as, for instance, formaldehyde. Now, if you were to ask yourself, or if anybody were to ask you what change

should be made in the procedure outlined there, so that the resulting product would be ethylene oxide instead of formaldehyde, would it be possible to find the answer to that question in the Lefort patent? A. I don't think so, sir.

Q. Take the Reyerson paper; he performed an oxidation of ethylene and air in the presence of a silver catalyst at an elevated temperature, did he not? A. Yes.

Q. And what did you understand were the products that he got? A. He got carbon dioxide and water.

Q. Now, if anybody had asked you, or if you had asked yourself what to do differently from what is disclosed in that paper as having been done by Reyerson, so that the resulting product instead of being CO_2 and H_2O would have been ethylene oxide, would you have found the answer to that question in the Lefort patent? A. I don't think so, sir.

Mr. Watson: The question is indefinite as to date. I have no idea what date the witness is speaking of.

Mr. Edmonds: Well, will you answer the question with respect to any date from the beginning of the world to 1940?

A. I will answer that in exactly the same way.

Cross Examination.

By Mr. Watson:

Q. You referred in your direct examination to the article by Wurtz, do you recall? A. Yes.

Q. That states, does it not: "Ethylene oxide can not be formed directly by the action of oxygen on ethylene?" A. May I see that?

The Court: Oh, I don't know that you need spend very much time on these prior art articles, because I understand the witness admits— A. That is right, on page 287.

Q. And it also says, "I have in vain endeavored to bring about direct combination of oxygen and ethylene." A. Yes.

Mr. Watson: I just wanted to dwell on a few of those to indicate immateriality.

Q. Do you agree with the statement that before 1931 the published art did not suffice as instruction how to practice direct oxidation of ethylene to produce ethylene oxide? A. I think that one has to bring the McElroy patents into the picture in order to answer the question thoroughly, but I think that there is a very good ground for believing that if one proceeded on the basis of the McElroy patents it would be possible to make ethylene oxide.

Q. That is roundabout, I would like you to answer the question: Do you agree or disagree with the statement that before 1931 the published art did not suffice as an instruction on how to practice direct oxidation of ethylene to produce ethylene oxide? A. I should probably disagree on that basis, on the basis of the McElroy patents * * * [1196-1220].

* * * The Court: Well, I don't know that I understand you. The witness is explaining, as I understand, that in spite of what appears to be considerable lack of specifications, he thinks that at least the later McElroy patent discloses the practice that is involved in the patent in suit. That is the sum and substance of your testimony?

A. That's right * * * [1220-1221].

* * * By Mr. Watson:

Q. You referred to the British Walter patent? A. Yes.

Q. That deals with the production of formaldehyde? A. Formaldehyde from ethylene and oxygen.

Q. No pretence of producing ethylene oxide at all in that patent? A. It does cover the partial oxidation of the hydrocarbons.

Q. But there isn't even an expression of a desire to produce ethylene oxide in that patent, is there? A. I don't think so.

Q. In any event, there is not a faint suggestion of an operating procedure whereby the ethylene oxide can be produced from ethylene and air, is that true? A.

Might I have an interpretation of "faint suggestion," your Honor? I mean, "faint suggestion" is a faint suggestion. I would like to go over it with a microscope * * * [1224-1225].

* * * Q. Willstatter states, doesn't he, that he found his catalysts utterly useless? A. For the preparation of formaldehyde.

Q. And the Reyerson article—I don't know whether you include that within the anticipation or not——

The Court: No, he states he did not.

Mr. Watson: But he spoke of it as a silver catalyst.

Q. As a matter of fact, that was a silverized silica gel catalyst, was it not? A. Yes.

Q. And so stated by the author? A. Yes.

Q. You spoke of results which might flow from using the Benton and Elgin catalyst in place of that silverized silica gel. Was there any foreshadowing in the art, prior to Lefort, that using the Benton and Elgin catalyst would have produced ethylene oxide by direct combination of ethylene and oxygen of the air? A. Not to my knowledge.

Q. Did you ever try to follow the McElroy disclosures? A. No. You mean, practice them?

Q. Did you ever attempt to duplicate them? A. No.

Q. Do you find any statement in either of the McElroy patents of the use of a catalyst of silver at a temperature within the range of 150 to 400 degrees Centigrade * * * [1225-1227]?

* * * A. The two together?

Q. That range of temperature— A. Plus? No.

Q. —and that catalyst that zone of temperature and catalyst? A. No, I do not find that.

Q. Do you find any suggestion in either of McElroy's patents of the use of silver alone as the catalyst? A. Silver alone as the catalyst? Well, if he passed ethylene and oxygen over a silver oxide catalyst in the

temperature range of 150 to 400, you would convert that silver oxide into silver.

Q. And that is no longer an oxide? A. Well, the question is, what is a metal catalyst? With an oxide layer on the surface, is it metal or is it an oxide • • • [1227-1228]?

• • • Q. Do you find a statement in either of the McElroy patents of the use of silver as a catalyst? A. No.

Q. Is it not true that McElroy's statement about the labile oxides concerns the selection of a metal compound with oxygen from which the oxygen is contemplated to be given up, and which oxygen thereafter is contemplated as the source of a reactant? A. I have never met Mr. McElroy, and consequently I can not answer the question.

Q. Irrespective, however, I have asked you whether you found the combination in McElroy of a catalyst having the catalytic characteristics of silver, or silver, and the temperature of 150 to 400 degrees, and you have told me you do not find that combination, is that right? A. Right.

Q. Do you find in the patent a statement of the desirability of using a temperature range of 150 to 400 degrees, even dissociated from the catalyst silver? A. I find the statement of a predetermined temperature range. I find that it is public information that from 100 degrees Centigrade upward the oxidation of the ethylene is beginning in the presence of catalytic agents, and, therefore, this is the range of temperature where I would expect the predetermination to finish up.

Q. And what maximum? A. Oh, with regard to the maximum I would suggest that 400 is a probable suitable maximum because it is at that temperature that ethylene oxide is quite markedly decomposing.

Q. Well, then, you have taken the burning of ethylene to carbon dioxide and water as fixing your 100 degree temperature, have you not • • • [1228-1230]?

• • • A. Yes, I would say that it has been known for nearly a hundred years, if not more than a hundred

years, that ethylene and oxygen, burned in the presence of catalytic agents to carbon dioxide and water at somewhere around 100 degrees Centigrade.

Q. And that would occur at a thousand degrees Centigrade? A. Yes, sir * * * [1230].

* * * Q. Doctor Taylor, do you find that McElroy states any different temperatures for his liquid phase method than for his gaseous phase? A. Yes, he is dealing with the electrolytic oxidation in the liquid phase process and I have never looked whether there is a temperature there.

Q. The question is whether there is any statement in the McElroy patent of a difference in temperature of the two cases, whether it is the liquid phase or gaseous phase? A. I cannot find any temperature in the case of the electrolytic oxidation.

Q. I am not speaking so much of particular temperatures. The question is whether you find any specification of different temperatures in the two cases? A. I cannot find any specification of temperature in the case of electrolytic oxidation.

Q. Well, then, what is the answer to my question? A. My answer to your question would be that in one case he specified a predetermined temperature range and in the other case he does not.

Q. What is that predetermined temperature range? A. The temperature at which ethylene and oxygen would react in contact with the catalyst in question.

Q. What is the statement in the McElroy patent of what that predetermined temperature range is, in figures, if any? A. There isn't any * * * [1234-1235].

* * * Q. How many intermediate oxidation products of ethylene are there? I am asking from a chemical viewpoint? A. A great many.

Q. Is it your position that the McElroy patents singly or together disclose processes for making all of these possible oxidation intermediates? A. No, it doesn't disclose all of those.

Q. How many does it disclose? A. I see three here.

Q. They are? A. The direct products of its limited oxidation, ethylene oxide, glycol and chlorhydrin. That is at the top of page, one, column two.

Q. And line 24 etc., do you find— A. Glycol, chlorhydrin, glycol esters, glycol ethers, ethylene oxide. They are oxygen containing or oxidized derivatives of ethylene.

Q. Is that all? What does the etc. stand for in line 27? A. The other products which we have not mentioned.

Q. Is it your opinion that the McElroy patents disclose operative processes for making all of those? A. It discloses operative processes for making those that he mentioned and those that he included under the term "etc."

Q. That is all the oxidation products possible, chemically, from ethylene? A. Am I to understand that you wish me in one stage——

Q. What is that? A. Am I to understand that you mean in one stage of operation?

Q. I don't care how many stages. A. Of course, it includes carbon dioxide and water as well.

Q. It includes the whole galaxy, doesn't it? A. Yes, I think Doctor Stevenson calculated the number.

Q. Is it your opinion again that McElroy disclosed operative processes for making that whole galaxy? A. He indicates methods whereby those can be produced from ethylene and oxygen.

Q. Did you ever attempt to duplicate the McElroy disclosure to see whether you got any of those? A. No.

Q. Do you know that Mr. McElroy is a patent attorney in Washington, D. C.? A. No.

Mr. Watson: Will you stipulate that, Mr. Edmonds?

Mr. Edmonds: He is a chemist. I have a copy of his letter paper here that says he is a chemist.

Mr. Watson: He is also a patent attorney, isn't he?

Mr. Edmonds: Oh, I think so.

Mr. Watson: And he is alive?

Mr. Edmonds: He is alive. He is getting along in years and because of his increasing years I was unable to induce him to come over here to testify at the trial. There was nothing I would like better than to have him here but he refused.

By Mr. Watson:

Q. Doctor Taylor, you are the co-author of a book with Mr. Rideal? A. Yes.

Q. The book has been referred to in somebody's testimony in the case? A. Yes.

Q. Do you know whether the witness Reyerson, who has testified, is also the co-author of the Reyerson article to which you referred? A. Yes, sir.

Q. Labile oxides include nitrous vapors, don't they? A. Yes.

Q. And they include non-metal compounds then as well as metal. A. Yes.

Q. Do you know whether, in your opinion, turning to the McElroy patent, in your opinion would you get ethylene oxide by passing ethylene and chlorine and steam together as indicated in line 93 to line 95 of the second column of the first page, would you get ethylene oxide that way? A. I don't know, but I don't think so.

Q. As of 1918, the date of this patent, was it known that ethylene and oxygen in the absence of catalysts would combine to make ethylene oxide directly? A. Not to my knowledge.

Q. You never tried it? A. No

Q. The nitrous vapors referred to line 98 include nitric oxide, nitrogen oxide and nitrous anhydride? A. I would hardly think nitrous vapors would include N_2O_5.

Q. It would include NO? A. NO, yes.

Q. And NO_2? A. And N_2O_3.

Q. And N_2O_3? A. Yes.

The Court: Is that all?

Mr. Watson: I have one more question, if the Court please. I hesitated to refer back to the Walter Patent, but there is a mention in it of red heat.

Q. (By Mr. Watson) Dr. Taylor, in the identification of temperatures by colors, red heat means 600 degrees, or in that neighborhood? A. To which place are you referring?

Q. Page 3 of the British Patent, line 31. But it is a general question. I just want an identification of temperature by the term "red heat." A. Red heat, I would say, it is not definitely known where it is, but I should say somewhere around five or six or seven hundred degrees.

Q. And in lines 45 et seq., Walter mentions the 400 degrees C. temperature only as a quotation from Beilstein's handbook. A. Yes * * * [1235-1241].

* * * Redirect Examination.

By Mr. Edmonds:

Q. If you were asked to practice the process described in the McElroy patent, using as the catalyst that labile oxide, silver oxide, and were also to practice the process of the Lefort Reissue, using as the catalyst that catalyst described there as silver oxide, what would you do? A. I would conduct approximately the same experimental investigation in the two cases.

Q. And what would you do about the temperature? A. I would start in something like Professor Lamb did, at a low temperature, and gradually heat up, and find out if there was a reaction, indicated first of all by the rising temperature, and then by an analysis of the product that was obtained.

Q. You have spoken of a Walter British Patent. I show you German Patent 168291. (Handing patent to witness.) Is that for substantially the same thing? A. Yes, sir. The date identifies it.

Mr. Edmonds: That is all.

I offer in evidence this German Patent No. 168291 just identified by the witness, together with the translation of the specification.

(German Patent No. 168291 marked "Defendant's Exhibit No. 83.")

(Translation of specification thereof marked "Defendant's Exhibit No. 84.")

RECROSS EXAMINATION.

By Mr. Watson:

Q. There is no difference between the British Walter and the German, so far as you know, is that true? A. I gather they roughly cover the same material.

Mr. Watson: That is all.

(Examination of witness concluded.)

Mr. Edmonds: I offer in evidence the copy of the Wurtz article referred to by the witness, Dr. Taylor, as Defendant's Exhibit 85.

(Copy of Wurtz article marked "Defendant's Exhibit No. 85.")

Mr. Edmonds: I offer in evidence a copy of Walter British Patent No. 21941 of 1905, also referred to by Dr. Taylor, as Defendant's Exhibit 86.

(Copy of Walter British Patent No. 21941, marked "Defendant's Exhibit No. 86.")

Mr. Edmonds: I also offer in evidence the Willstatter & Bommer article of 1921, together with the translation of it, as Defendant's Exhibits 87 and 88.

(Willstatter & Bommer article of 1921 marked "Defendant's Exhibit No. 87.")

(Translation of Defendant's Exhibit 87 marked "Defendant's Exhibit No. 88.")

Mr. Edmonds: I also offer in evidence a copy of McElroy Patent No. 1253617, as Defendant's Exhibit 89.

(Copy of McElroy Patent No. 1253617, marked "Defendant's Exhibit No. 89.")

Mr. Edmonds: And also a copy of McElroy Patent No. 1308797, as Defendant's Exhibit No. 90.

(Copy of McElroy Patent No. 1308797, marked "Defendant's Exhibit No. 90.")

Mr. Edmonds: I also offer in evidence a copy of the paper written by Dr. Taylor, to which he referred in his testimony, printed in the Journal of the Franklin Institute for 1922. That will be Defendant's Exhibit 91.

(Copy of paper written by Dr. Taylor, printed in the Journal of the Franklin Institute, for 1922, marked "Defendant's Exhibit No. 91.") * * * [1241-1245].

* * * * * *

TESTIMONY OF RAY M. CARTER

Thereupon——

RAY M. CARTER, a witness of lawful age, produced on behalf of the Defendant, having been first duly sworn according to law, was examined and testified as follows:

Direct Examination.

By Mr. Barrows:

Q. How are you employed, Mr. Carter? A. By the U. S. Industrial Alcohol Company in the research laboratory in Stamford, Connecticut.

Q. How long have you been employed by that company? A. I have been employed by that company since 1917.

Q. What briefly has been your technical training and experience? A. I graduated from the University of Maine with the degree of Bachelor of Science in Chemistry and obtained a master's degree in science in the University of Maryland.

Q. How long have you been employed by the U. S. Industrial Alcohol Company? A. Since 1917, that is twenty-three years.

Q. What briefly has been the nature of your work over that period? A. At the start it was largely analy-

tical work and in charge of analytical work and following that research work on various problems of an organic nature.

Q. When did you first become interested in the production of ethylene oxide and glycol? A. Around about 1934.

Q. And you were then in the research laboratory of the company at Stamford? A. That is correct.

Q. How long after that did you continue to be interested in the production of ethylene oxide and glycol? A. I have been interested in that up to this time.

Q. Sometime during the course of that work did you personally try to use silver as a catalyst in the oxidation of ethylene? A. I did.

Q. And at what time was that? A. December, 1935.

Q. How did you happen to use silver as a catalyst at that time? A. We first used silver at that time because we had just finished in the laboratory a process in which silver had been used as a catalyst in the partial oxidation of isopropyl alcohol.

Q. What kind of silver catalyst was that? A. We used that particular form of silver which had been used in that prior work. It was silver in the form of rivets, small rivets.

Q. That was a satisfactory catalyst in this other process? A. Very satisfactory, yes, sir.

Q. What results did you find when you used that as a catalyst to oxidize ethylene? A. We didn't find very good results with that. The maximum conversion of ethylene to ethylene oxide was about 4-3%.

Q. Under what conditions did you obtain that result? A. We used a glass reaction vessel, pyrex tube, essentially like the one shown here yesterday, filled with silver rivets to a depth of 13 inches, and using a mixture of 5 per cent. ethylene and 95 per cent. air. We obtained in our first test a maximum conversion of 2.3 per cent.

Q. Under what conditions? A. The temperature at that time was 417 to 425 degrees Centigrade.

Q. Will you go ahead and describe the experiment you carried out? A. Following that the percentage of ethylene was changed from 5 per cent. to 90 per cent.—90 per cent. ethylene and 10 per cent. of oxygen, and a temperature of 386 to 445, and the conversion was .2 of 1 per cent., as compared with 2.3 previously obtained.

Thinking that the depth of 13 inches was not sufficient, we changed the reactor to 1 inch rather than 1⅛ inch, and got a depth of 25 inches of silver rivets, and were able to get a maximum conversion of 7 per cent., at a temperature of 458 to 465 degrees, with a mixture of 5 per cent. ethylene and 95 per cent. air.

Q. Now, you have used the term "conversion." What does that mean, Dr. Carter? A. By conversion I mean the percentage of input ethylene which is converted to ethylene oxide in the operation.

Q. Now, how did the results obtained by this test compare with the results that you previously obtained in the oxidation of ethylene? A. The conversion of ethylene to ethylene oxide was much greater with the silver rivets than by any other method which we had investigated up to this time.

Q. And had you, prior to this time, investigated various methods of oxidizing ethylene catalytically? A. We had.

Q. Including the use of silver as a catalyst? A. Silver gauze.

Q. And you say up to that time you had never obtained as high a production of ethylene oxide with the catalyst as you obtained without a catalyst? A. Will you repeat that, please?

Q. Well, I will withdraw the question. Will you state again how these results obtained by this experiment in December, 1935, with silver rivets compared with the results previously obtained in oxidizing ethylene without a catalyst? A. They were much higher, much higher than anything we had obtained in catalytic oxidation prior to this time, prior to the use of the silver rivets.

Q. And I believe you referred to a comparison of the oxidation of ethylene with catalysts and the oxidation

of ethylene without catalysts? A. I think you mentioned it in that last question. That is why I was not sure, and asked you to repeat it.

Q. Well, had you, prior to this experiment in December, 1935, carried out experiments in oxidizing ethylene in air without a catalyst? A. We had.

Q. And also with a catalyst? A. That is correct.

Q. A small number, or large number of catalysts? A. Quite a large number of catalysts.

Q. Including silver? A. Including silver.

Q. And how did your results prior to December, 1935, with catalysts, compare with your results without catalysts, in that oxidation? A. Oh, the results with catalysts prior to the silver rivet run were poorer than the results without catalysts.

Q. How did the results obtained with the silver rivets compare with the results previously obtained without a catalyst? A. They were much higher than the conversion obtained previously without catalysts.

Q. Now, did you subsequently investigate the use of silver rivets further after these experiments you have referred to? A. We did. We took another lot of the silver rivets and etched them with nitric acid.

Q. What was the purpose of that? A. We thought we might thereby increase their surface, and perhaps increase their catalytic effect * * * [192-198].

* * * Q. Mr. Carter, you recall that the original describes the addition of water to the air and ethylene used in the process of making ethylene oxide. A. Yes * * * [204-205].

* * * Q. Well, did you, Mr. Carter, carry out any experiments with the addition of water in that process, in comparison with the experiments when water was not used? A. Yes, we did.

Q. Will you describe what experiments you did? A. We had a silver on pumice catalyst.

Q. When did you carry out that experiment? A. That experiment was carried out the 23rd of April, 1936. It.

was a silver pumice catalyst. 5 per cent. ethylene, 95 per cent. air, was passed over that catalyst, at the rate of two feet an hour, the water passing through a water hydrator at approximately 90 degrees Centigrade, which would have given a steam content of about 40 per cent. to the vapors, at 392 to 407 degrees Centigrade. Only 1.8 per cent. of ethylene oxide was the conversion. The hydrator was then by-passed so that no steam went through with the ethylene and air, and at a temperature of 386 to 410, which is very close to the previous one. And the conversion rose to 6.5 of ethylene oxide, showing about three-fold decrease in ethylene oxide with the steam * * * [205-206].

* * * Q. You found that particular catalyst with steam had the effect of very materially decreasing the catalytic effect? A. It had a deterrent effect, yes.

Q. And where is the experiment recorded in your notebook? A. That is in Notebook 1116, at page 19.

Q. And does that end on that page or extend over to the next page? A. It is pages 19 and 20.

Q. Now, did you try water with any other catalyst besides silver on pumice? A. Yes, we tried the effect of steam with silver, on silica gel catalyst.

Q. What time did you try that? A. 21st of April, 1936.

Q. Will you describe what you did there? A. We were using a silver silica gel catalyst in a pyrex tube and a gas mixture containing five per cent. ethylene, and ninety-five per cent. air was passed through the catalyst tube at the rate of 2 cubic feet an hour at a temperature of 284 to 316, a trace of ethylene oxide was formed.

The gas flow was increased to 10 feet an hour and the temperature immediately rose to 450, indicating complete combustion. The ethylene concentration was then cut back to one per cent. and a conversion of 1½ per cent. ethylene oxide was obtained. The inlet gas was then saturated with water as before, giving about 40 per cent. steam concentration and the conversion of ethylene rose to 3.6, about double.

Q. That is in this case the addition of water more than doubled the production of ethylene oxide as compared

with the result obtained without the addition of water. A. Water was beneficial in this case, and it did just that.

Q. At what pages in your notebook is this experiment described? A. It is the same notebook at pages 15 and 16, 17 and 18.

Q. Beginning on what page? A. 15. 16, 17 and 18.

Q. Does page 13 of this notebook relate to this experiment? A. Yes, it does begin on page 13. That is the description of the catalyst chamber.

Q. Now, do your records show how this particular catalyst was prepared? A. Yes.

Q. And do you have a record of that particular preparation? A. Yes, it is in Notebook 1106, I believe.

Q. At what page? A. Page 21.

Mr. Barrows: I offer in evidence as Defendant's Exhibit 7 photostat of pages 13, 15, 16, 17 and 18, showing the record of the experiments described by the witness.

(Pages 13, 15, 16, 17 and 18 of Dr. Carter's Notebook 1106, marked in evidence, "Defendant's Exhibit 7.")

Mr. Barrows: I offer in evidence as Defendant's Exhibit 8, page 21 of the notebook describing the method of preparing the catalyst.

(Page 21 of Dr. Carter's Notebook, marked "Defendant's Exhibit 8.") * * * [207-209].

* * * Mr. Barrows: I think you prepared a brief summary of the notebook records in the form of a connected story on this experiment?

A. Yes.

Mr. Barrows: I offer in evidence a summary of the experiment as Defendant's Exhibit 9.

(Summary of experiments in connected form, marked "Defendant's Exhibit 9.")

Q. Dr. Carter, in this earlier experiment with pumice of April 23, 1936, do you have a description of how the catalyst used in that experiment was prepared? A. That occurs on page 17 of the Notebook 1106.

Mr. Barrows: I offer in evidence photostat copy of pages 19 and 20, describing this experiment of April 23, 1936, as Defendant's Exhibit 10.

(Pages 19 and 20 describing experiment of April 23, 1936, marked "Defendant's Exhibit 10.")

Mr. Barrows: I offer in evidence page 17 of the other notebook describing the preparation of the catalyst as Defendant's Exhibit 11.

(Page 17 of Notebook describing preparation of catalyst used in the experiment of April 23, 1936, marked "Defendant's Exhibit 11.")

Q. And have you similarly prepared by request a summary of this experiment, Dr. Carter? A. Yes, sir, I have.

Mr. Barrows: I offer this summary as Defendant's Exhibit 12.

(Summary of experiment of April 23, 1936, marked "Defendant's Exhibit 12.")

Q. Dr. Carter, prior to the time you carried out these experiments where you added water and operated with and without water, how many carriers had you tried as carriers or supports for silver catalysts? A. We tried only one: pumice.

Q. And the silica gel was the next one you tried? A. Silica gel was the next one.

Q. And what was the next one you tried? A. I believe the next we used was activated alumina.

Q. Did you find that a satisfactory support? A. It was not. It was a very unsatisfactory support.

Q. Did you produce any ethylene oxide whatever with that support? A. It produced none at all.

Q. Did you investigate to see whether you could do anything to make that support satisfactory? A. Yes, we treated and washed the activated alumina with acid in an attempt to remove any alkaline materials that might be there, to see if such a treatment would result in a better catalyst, and it did not.

Q. What was the next carrier support that you tried? A. Infusorial earth.

Q. Did you find that a satisfactory support? A. No, sir, that was not a satisfactory support.

Q. Can you identify the notebook where you tried these supports, alumina and the infusorial earth? A. Yes, sir, alumina is given, starting at page 21, 22, of Book 1116, at pages 27 and 28 of the same notebook.

Q. What was the date of those experiments? A. April 25, 1936, and May 4, 1936.

Q. And have you prepared at my request a summary of these experiments? A. I have.

Q. And can you identify the notebook pages showing how the catalysts were prepared that were used in these tests? A. Yes, sir, in Notebook 1106, page 29, for the first alumina experiment mentioned, and page 33 for the second.

Mr. Barrows: I offer in evidence photostat copies of pages 21 and 22 for the experiment dated April 25, 1936, as Defendant's Exhibit 13.

(Pages of photostat copy, pages 21 and 22, for experiment dated April 25, 1936, marked "Defendant's Exhibit 13.")

Mr. Barrows: I offer in evidence page 29 of the notebook describing the catalyst.

(Page 29 of Notebook describing the catalyst, marked "Defendant's Exhibit 14.")

Mr. Barrows: And a brief description of that experiment is offered in evidence.

(Brief description of experiment of Dr. Carter, April 25, 1936, and May 4, 1936, marked in evidence, "Defendant's Exhibit 15.")

Mr. Barrows: And I offer in evidence pages 27 and 28 of experiment dated May 4, 1936.

(Pages 27 and 28 of the experiment dated May 4, 1936, marked in evidence, "Defendant's Exhibit 16.")

Mr. Barrows: Also page 33, describing the production of the catalyst used in this experiment.

(Page 33, describing preparation of the catalyst used in experiment of May 4, 1936, marked "Defendant's Exhibit 17.")

Mr. Barrows: And the summary sheet describing the experiment.

(Summary sheet describing experiment of May 4, 1936, marked "Defendant's Exhibit 18.")

Mr. Barrows: I also offer in evidence pages 44 and 45, describing experiment of May 4, 1936.

(Pages 44 and 45, marked "Defendant's Exhibit 19.")

Mr. Barrows: And a summary of that experiment.

(Summary of experiment of May 4, 1936, marked "Defendant's Exhibit 20.") * * * [210-2[illegible]].

* * * I offer the pages of the experiment of May 7, 1936, using silver on infusorial earth, comprising pages 29, 30, 31, 33, 34 and 35.

(Pages of experiment of May 7th, 1936, marked "Defendant's Exhibit 21.")

Mr. Barrows: We now offer the page showing the method of preparing the catalyst, page 37 of Mr. Carter's notebook.

(Page 37 of notebook marked "Defendant's Exhibit No. 22.")

Mr. Barrows: And the next a summary of this experiment.

(Summary of experiment, pages 29 to 35 of book 1116, marked "Defendant's Exhibit 23.")

By Mr. Barrows:

Q. Before getting into this detail, can you enumerate other carriers that you tried as support for the silver catalyst and which you found a non-satisfactory support for that purpose? A. Yes, on June 15, 1936, I found that aluminum silicate, silver on that gave no ethylene oxide. Ethylene was burned but no ethylene oxide was formed.

On the 22nd of June we used silver mounted on fire clay and we found a maximum conversion of nine-tenths of a per cent. of ethylene oxide. On the 25th of June we tried silver mounted on glass wool and up to 347 degrees Centigrade there was no reaction. At 453 degrees we had two and a half per cent. conversion to ethylene oxide. On July 3, 1936, we tried silver on asbestos and the maximum conversion which we could get with that was 4.3% at 350 degrees Centigrade. On the 20th of August of 1936 we tried silver on carborundum and our maximum conversion there was 1.4% at 350 degrees. Then on June 11th we prepared silver from tartrate by decomposition by heat, leaving a very light and spongy silver and the maximum conversion with that was 3%. No carrier, just plain spongy silver. We followed that by having silver prepared on pumice and then decomposing that to give us the silver from the tartrate on the pumice and up to 450 degrees Centigrade there was zero conversion of ethylene, starting at a temperature of 200 to 400. Then on the 16th of June, 1936, we took the spongy silver prepared by decomposition of tartrate and laid down on it silver from silver nitrate by evaporation of silver nitrate upon this spongy silver and reduced that with hydrogen and got a maximum conversion of one per cent. of the input ethylene at 350 degrees.

Q. Some of these catalysts you described were silver without a support? A. Yes, the silver with the tartrate was without a support.

Q. And you found no ethylene oxide whatever with some of these experiments? A. That's right.

Q. And the other catalysts were made with silver on various supports? A. Yes.

Q. And many of those gave no ethylene oxide whatever? A. Yes.

Q. And some gave only traces? A. Some gave very small amounts and some gave amounts essentially traces and some gave none at all.

Q. After you had carried out these experiments in which you added water and tried pumice and silica gel, alumina and infusorial earth, did you have occasion to

record your views on the catalysts in your notebook at that time? A. Yes.

Q. Can you identify the pages where you did that? A. Yes, sir, starting on page 53.

Q. What date was that? A. The 28th of May, 1936.

Q. How long had you been working on silver catalysts up to that time? A. I had worked from the latter part of December, 1935, up to this date on the silver catalyst.

Q. How many different catalysts had you made during this time? A. The preceding one was the 49th—no, I beg your pardon.

Q. The 49th experiment? A. The 49th experiment, the 24th catalyst.

Mr. Barrows: I offer in evidence the notes of the witness as of May 28th, 1936 as Defendant's Exhibit 24.

(Notes of Mr. Carter of May 28th, 1936, marked "Defendant's Exhibit No. 24") * * * [218-222].

* * * By the Court:

Q. In that summary do you state what you find to be a satisfactory silver catalyst? A. At that time I had not found a satisfactory silver catalyst. That is the purport of that statement.

By Mr. Barrows:

Q. What were your conclusions as to the effect of the carrier on these catalysts or the method of preparation of the catalysts up to this time? A. Our results had shown that the effect of the carrier was very marked. Obviously there were certain carriers which did not give with silver the catalyst which we expected in the formation of ethylene oxide. Pumice was the best one at the moment. Most of the others were no good at all or so bad as to be of no commercial significance.

Q. What conclusion did you reach as to pumice? Would you say it was the best thing you tried up to that time? A. Pumice catalysts were the best we had found at that time. They had the disadvantage that their activity

decreased very rapidly with use, so rapidly that they were entirely out of the picture as far as commercial operation was concerned at that time. They just would not hold their activities for a long enough period to be of any benefit.

Q. What is pumice chemically? A. It is essentially an aluminum silicate, I believe, but has a lot of other material present in small amounts. I don't recollect right offhand the exact composition of it.

Q. You suggest then that these impurities may have affected the catalyst? A. I thought some of these impurities there may be acting in such a way as to make pumice definitely better than these other materials which we tried and which we had every reason to believe might be produced.

Q. Did you try aluminum silicate in a pure state without the presence of pumice? A. Yes, that's what we did. It represented a pure form of constituent parts of pumice. We thought if we tried it in pure form, we might get some information which would be of help.

Q. In the course of your experiment, Mr. Carter, did you try a copper catalyst as a catalyst for oxidizing ethylene? A. Yes.

Q. What result did you obtain? A. We had complete oxidation of the ethylene to CO_2, no ethylene oxide.

Q. Now, you refer to these experiments with silver gauze. Will you identify the notebook that records those experiments? A. I believe it is No. 1047.

Q. What page in that notebook. A. The silver gauze?

Q. Yes. A. On page 140 and 141.

Q. Do those pages need any preceding pages to explain them? A. Yes, the apparatus is pictured on an earlier page, page 128.

Q. What page should be included to get the whole story of this silver gauze experiment? A. 128 would be needed.

Q. Beginning at page 128 up to the pages you have referred to? A. Yes, pages 140 and 141.

Q. And what results were obtained with this silver gauze experiment? A. The maximum conversion of ethylene to ethylene oxide in this silver gauze experiment was .7 of 1 per cent.

Q. At what temperature? A. At a temperature of 530 to 545.

The Court: What is silver gauze?

The Witness: It is just like a screen, a window screen, only made of silver wire. It was a fine silver wire, made in the shape of a net, network, just like a screen.

Q. (By Mr. Barrows) And is that a common form of silver for catalytic purposes? A. So far as I know, yes, sir.

Q. Now, you say you got about .7 of 1 per cent at a temperature of around 530 to 545? A. Yes, sir.

Q. Is that Centigrade? A. That is Centigrade.

Q. Now, within the range of the Lefort Patent of 150 to 400 degrees, what results were obtained? A. About .05 of a per cent.

Q. .05 of 1 per cent? A. .05 of 1 per cent conversion.

Q. Now, the prior pages that you said were necessary to understand this experiment cover the use of a platinum gauze, and empty, without any gauze at all in it? A. That is correct.

Q. And how did the results obtained with the silver gauze compare with the results obtained without any gauze at all in the apparatus? A. Without any gauze at all we were able to get, with the same apparatus, a conversion of ethylene of about .8 of a per cent, compared to the .7 obtained with the silver gauze.

Q. And at a somewhat higher temperature? A. That was at a temperature of about 610 degrees.

Q. And have you prepared, at my request, a brief summary of this silver gauze experiment? A. Yes, here it is.

Mr. Barrows: I offer in evidence a photostat copy of this, identified by the witness, relating to this silver gauze experiment, and also the witness's summary of this experiment.

(Photostat copy of silver gauze experiment, and witness's summary of same, marked respectively, "Defendant's Exhibit No. 25" and "Defendant Exhibit No. 26.")

Q. (By Mr. Barrows) Mr. Carter, in referring to the silver which you said you tried in your experiments, you said you did get some results there at a rather high temperature? A. Yes.

Q. Considerably higher than the temperature range of the patent in suit, for your best result? A. That is true. The best results were obtained at temperatures above 500 degrees.

Q. And then you tried silver rivets, treated with nitric acid, and got no results at all? A. That is correct.

Q. How did you explain the difference between those results? One gave no ethylene oxide, and one gave some at a high temperature? A. Well, the only things that I know of that have a bearing on that are the fact that the silver rivets which were first used, that is the untreated ones, not nitric acid treated, those rivets had been used previously in this oxidation of isopropyl alcohol; and their surface had the mat effect, and was an oxidized silver surface. That probably indicated a more active silver surface than the original rivets had. Why the nitric acid treated ones should have been inactive, I do not know. They just were.

Mr. Barrows: I find I did not offer in evidence the pages, the notebook records of experiments with silver rivets. I offer the pages from notebook 1074, describing the experiments, as Defendant's Exhibit 27.

(Pages describing experiments, from Notebook 1074, marked "Defendant's Exhibit No. 27.")

The Court: Do I understand you to say that you have or have not found, up to the present time, a satisfactory catalyst?

The Witness: You mean at the present time, right now?

The Court: Yes, now.

The Witness: Oh, yes, we have now.

The Court: Of silver?

The Witness: Yes, we have a satisfactory catalyst as of this date.

Q. (By Mr. Barrows) And how many months did it take you before you arrived at a satisfactory catalyst? A. We arrived at that satisfactory catalyst late in '36, somewhere around about November, 1936, I believe. We started this work in December of 1935, active work on the silver catalyst.

Q. And how many catalysts had you made between the time you started in December, 1935, and the time you found a satisfactory catalyst in 1936? A. I do not remember the exact number, but it was a lot, somewhere around a hundred.

The Court: Well, do I understand it is this catalyst consisting of silver disposed on a carrier of aluminum oxide, bonded by a fusion process?

The Witness: That is correct.

The Court: That is the one.

The Witness: That is correct.

Q. (By Mr. Barrows) And how many other carriers had you tried before you arrived at this one as a satisfactory carrier? A. We had tried probably twice as many as I have related this morning. I do not have the exact number in my mind. At least twice as many than those——

The Court: Twice as many. How many does that come to?

The Witness: Twice as many as we have gone over this morning.

The Court: How many does that come to in number?

The Witness: Now, let me get this clear. Do you want to limit this to what date, the date as of the alundum catalyst, or the date that we have been talking about here?

The Court: No, I was not limiting it to any date.

The Witness: Oh!

The Court: How many experiments, or how many different catalysts did you use before you reached the good one?

The Witness: Approximately one hundred catalysts were made before we reached a good one.

Mr. Fairbank: How many carriers?

Q. (By Mr. Barrows) How many different carriers? A. I would have to estimate that without going through the notebook and look at it.

Q. Could you give a rough estimate? A. I should say probably 40.

The Court: Forty?

The Witness: Yes, sir.

Q. (By Br. Barrows) Now, in addition to the carriers, did you investigate different methods of preparing the catalyst, different chemicals to be used in preparing it, different temperatures of reducing it, or otherwise preparing it, and different percentages of silver on the carriers? A. We did.

Q. What did you find as to the effect of different conditions in preparing the catalyst upon the results obtained by the catalyst? A. We found that the activity of the catalyst varied largely with the way in which the silver was put on it, whether it was put on by evaporation of silver nitrate, or whether it was prepared by deposition of silver hydroxide.

The Court: Now, are those differences included in these one hundred different catalysts you are talking about?

The Witness: Yes, your Honor.

The Court: In other words, they would all be part of these one hundred different catalysts?

The Witness: Yes, your Honor.

The Court: I do not think you need to go all over that again.

Q. (By Mr. Barrows) Well, in addition, Mr. Carter, isn't it also a fact that with an individual catalyst you made many changes in trying to reactivate it, or increase its activity, and subsequently treat it to make it into a catalyst? A. We did * * * [222-235].

* * * Q. (By Mr. Barrows) From your experience, Mr. Carter, in making a silver catalyst for the oxidation of ethylene oxide, what would you say as to the sufficiency of the Lefort Reissue Patent as to how to prepare a satisfactory catalyst? A. In my estimation it is totally insufficient in directions of how to prepare a satisfactory catalyst, silver catalyst.

The Court: You mean it is insufficient both as to describing the way to use the silver, and also the preparation of the supporting carrier?

The Witness: Yes, it neither tells you what support, what to use, how much silver to put on it, how to put that silver on it. It gives you no directions as to the preparation of the support of the catalyst.

The Court: Well, does your answer apply equally well to both patents?

The Witness: In that respect, yes, sir.

The Court: Well, we are only talking about the catalyst.

The Witness: Yes, the supported catalyst.

Q. (By Mr. Barrows) Let me ask you, Mr. Carter, at the time, or when did you first learn about the original Lefort Patent? A. The U. S. original?

Q. Yes. Do you recall it? A. I have no record of the exact date when I first saw it; but it was shortly after the office received a copy of it.

Q. And you recall that there were earlier foreign patents, with a similar disclosure? A. Yes, I have seen those.

Q. Do you recall when you first saw those? A. About 1933.

Q. And did you find anything in those foreign patents, or in the patents in suit, the patent originally granted, to

help you in your experimental work in making ethylene oxide? A. No, sir, we did not.

Mr. Barrows: To complete the offer of the records on the experiment with the silver rivets, I offer page 27, describing the treatment of the rivets, under date of April 21, 1936.

(Page 27, under date of April 21, 1936, describing treatment of silver rivets, marked "Defendant's Exhibit No. 28.")

Mr. Barrows: And pages 43 to 45, describing the later experiment in which those treated rivets were used.

(Pages 43 to 45, describing later experiment in which treated rivets were used, marked "Defendant's Exhibit No. 29.")

Mr. Barrows: And also the summary of the experiments as prepared by the witness.

(Summary of experiments as prepared by witness, marked "Defendant's Exhibit No. 30.")

Q. (By Mr. Barrows) Mr. Carter, referring to the experiments on pumice which had been made, experiments which had been made on pumice as a carrier for the silver, up to the time of your notebook entry at the end of May, 1936, have you prepared brief statements of the different experiments in which you used pumice as a carrier? A. I have.

Q. And in these are identified the pages of the notebook describing those experiments? A. That is correct.

Q. And you have had photostatic copies made of those pages pertinent to these experiments? A. Yes, sir.

Q. And also identify the pages of the notebook describing the catalyst? A. Yes, sir.

Mr. Barrows: I offer in evidence the group of summary reports of the experiments.

(Group of summary reports of experiments, marked "Defendant's Exhibit No. 31.")

Mr. Barrows: And also as one exhibit, the various notebook pages describing these various experiments.

(Various notebook pages describing various experiments, marked "Defendant's Exhibit No. 32.")

Mr. Barrows: And as another exhibit, pages of the notebook describing the preparation.

(Pages of notebook describing preparation, marked "Defendant's Exhibit No. 33.")

Q. (By Mr. Barrows) Mr. Carter, these notebooks that you have produced and discussed were notebooks kept in the regular course of business in recording laboratory experiments as they were made at the time? A. Yes, sir, they are.

Q. And these have been produced from the files of the company and are the original records of the company? A. They are.

Q. Mr. Carter, you have referred to various catalysts, some silver without a carrier and some silver on a carrier, subsequent to the memorandum in your notebook at the end of May, 1936. Have you prepared summary statements of these various experiments? A. I have.

Q. Identifying the notebooks describing them? A. I have.

Mr. Barrows: I offer in evidence these summaries and notebook records as follows—let me ask you, Mr. Carter, these summaries have been made recently?

A. Yes, sir.

Q. And to simplify describing these experiments which are prepared in laboratory form, and not so easy to understand unless you are familiar with the shorthand used in the experiment? A. Yes, it would be a little easier to get the purport of the experiment by reading the summary and not having to go through all the figures in the notebook.

Mr. Barrows: Yes. I offer in evidence the summary of the experiment of June 15, 1936, silver on aluminum silicate, together with the accompanying notebook pages as one exhibit.

(Summary of experiment of June 15, 1936, silver on aluminum silicate, together with notebook pages, marked "Defendant's Exhibit 34.")

Mr. Barrows: Similarly I offer as one exhibit summary of the experiment of June 22, 1936, and accompanying notebook pages dealing with silver on fire clay.

(Summary of experiment of June 22, 1936, and notebook pages, silver on fire clay, marked "Defendant's Exhibit 35.")

Mr. Barrows: I also offer as one exhibit a brief description of the experiment of June 25, 1936, with the accompanying notebook pages dealing with silver on glass wool.

(Brief description of experiment of June 25, 1936, with notebook pages, dealing with silver on glass wool, marked "Defendant's Exhibit 36.")

Mr. Barrows: I offer as one exhibit the summary of experiments of July 3, 1936, July 8, 1936 and July 10, 1936, with accompanying notebook pages, dealing with silver on asbestos.

(Summary of experiments of July 3, 1936, July 8, 1936, July 10, 1936, and notebook pages, dealing with silver on asbestos, marked "Defendant's Exhibit 37.")

Mr. Barrows: I offer as one exhibit the summary and the accompanying notebook pages covering the experiment of August 20, 1936, dealing with silver on carborundum.

(Summary of experiment of August 20, 1936, and notebook pages dealing with silver on carborundum, marked "Defendant's Exhibit 38.")

Mr. Barrows: I offer as one exhibit a summary and the accompanying notebook pages of experiment of June 11, 1936, dealing with spongy silver.

(Summary of experiment of June 11, 1936, and notebook pages dealing with spongy silver, marked "Defendant's Exhibit 39.")

Mr. Barrows: I also offer as one exhibit the summary and the accompanying notebook pages of experiment dated June 16, 1936, dealing with spongy silver impregnated with silver from silver nitrate.

(Summary of experiment of June 16, 1936, and notebook pages, dealing with spongy silver impregnated with silver from silver nitrate, marked "Defendant's Exhibit 40.")

Mr. Barrows: I also offer as one exhibit, summaries of experiments of June 12, July 16 and July 24, 1936, and the accompanying notebook pages, dealing with silver from a decomposition of tartrate used on pumice.

(Summaries of experiments of June 12, July 16 and July 24, 1936, and accompanying notebook pages, dealing with silver from a decomposition of tartrate on pumice, marked "Defendant's Exhibit 41.")

The Court: Mr. Carter, let me see if I understand the sum and substance of your testimony. Is it this, that you were called upon by your company to engage someone skilled in the art, that is, someone that you thought was sufficiently technically trained in the art, to make catalysts in accordance with either one or both of the patents in suit; you were directed by your superiors to engage so many people to do this; do I understand you to say that you feel that the description in the specifications with respect to catalysts and carriers in either one or both of the patents are so incomplete, so insufficient, that upon being given such direction you would feel that you would have to give to those subordinates of yours, these people you were employing for this purpose, a great deal more information or a great many more directions than are contained in either one of the patents before you would feel that they, even though thoroughly skilled in the art, could make a satisfactory silver catalyst?

A. Yes, your Honor. As the result of our experiments I would say that that exactly sums up the situation.

Mr. Barrows: Now, let me follow that up a little bit further, Mr. Carter:

Q. In all these experiments that you have described with silver on various carriers, you have formed mixtures of air and ethylene passing through a chamber containing these catalysts at a temperature within this temperature range of 150 to 400 degrees Centigrade, and

have tested the product from that process to see whether there was any ethylene oxide produced? Is that correct? A. That is true. That is correct.

Q. And in many of these experiments where you have used a silver catalyst in accordance with all these conditions you have produced no ethylene oxide whatever? A. That is correct.

The Court: Well, I meant, of course, in putting my question, that these people were being employed to make these catalysts for this purpose and to do it for a successful purpose.

The Witness: Yes, that's what I understood you to mean.

By Mr. Barrows:

Q. Well, Mr. Carter, isn't it a fact that you had a staff of other men besides yourself working on this very problem over the very period you are referring to? A. Yes, we had several men working on it.

Q. And doing your utmost to get a method of producing ethylene oxide? A. We were certainly trying hard.

Q. And the whole purpose of trying these experiments was to find a catalyst that would work? A. That is correct.

Q. And were there frequent conferences among the men of your laboratory as to what to do to get the final results? * * * [235-246].

* * * A. Yes, we would normally hold conferences on the problems on which we were doing work.

Q. Now, of all these silver catalysts which you have made and tried, do you know of any way of telling what silver catalysts favor the direct oxidation of ethylene to ethylene oxide in a mixture of ethylene and air, and which do not favor the existence of substantial amounts of aldehydes in the products? A. No, I do not. Our experience in the manufacture or testing, rather, of catalysts, led us to believe there was no way that you could tell what catalysts or what preparation of catalysts would be active for this particular reaction until you made it and tried it.

The Court: Now, I understand, again, summarizing your testimony, that you flatly disagree then with Dr. Stevenson, who has said that this process, which is described by this reissue patent, of which the model has been set up and you have seen him analyze the model and the process in the model, he says that anyone skilled in the art, following the teachings of the patent, could work out a satisfactory catalyst and could make the given product in a way that would make it commercially satisfactory. You disagree with that?

A. I think it could be worked out, your Honor. I agree with him to that extent.

The Court: Well, you say it could be worked out only after fretting around?

A. That is correct.

The Court: That one who has not made the experiment that you have already made, that one would have to fret around and try an infinite number of catalysts on an infinite number of carriers?

A. Yes, your Honor, you would have to experiment, largely by the method of cut and try, until you could arrive at what compound gave you good, substantial commercial results.

By Mr. Barrows:

Q. And isn't it a fact also, Mr. Carter, that taking the description of the Lefort patent and the conditions which it tells you to observe and the procedural features of the claim except those that define the catalyst in terms of results, and the conditions in terms of result, that in many of these experiments that you carried out you observed all of those conditions, except as to the functional definition of a catalyst? A. Yes.

Q. That is, you used the silver catalyst under conditions precisely those described in the patent except so far as defined in terms of result? A. That is correct * * * [246-248].

CROSS EXAMINATION.

By Mr. Watson:

Q. By whom were you employed from 1934 to 1937, Dr. Carter? A. By the U. S. Industrial Alcohol Company.

Q. During that interval you worked at the Stamford Laboratories? A. 1933? Yes, I did, from '32 on.

Q. '34 to '37? A. Yes, sir.

Q. And what company owns the Stamford Laboratories? A. That is something beyond by knowledge.

Q. Briefly, what was the nature of your work over the various periods since 1917 up until the time you began the work to which you testified? A. In the first few years after 1917 I did largely analytical work in the research laboratory of the Alcohol Company of Baltimore. Then followed a period of some five or six years during which I was in charge of the Analytical Division of that laboratory. Following that I worked on various research problems that were assigned to me.

Q. Briefly, by the fall of 1935 what experience did you have in the art of catalytic analysis? A. Relatively little.

Q. When did you first study the original U. S. Lefort patent? A. The exact date I don't remember, but it was shortly after it came out.

Q. Dr. Carter, the main product of the U. S. Industrial Alcohol Company has been ethyl alcohol? A. That has been one of its main products.

Q. And that applies for twenty-five years? A. Yes, about.

Q. About how many years has ethyl alcohol been used as the source of ethylene? A. Commercial source of ethylene? I should say from memory about twenty years or more.

Q. Over the period from February, 1935, to November, 1936, as to which you have testified, did you personally do or supervise all of the work of which you have given us records? A. Yes, I think that is a correct statement.

Q. In the period which I have referred to, so far as concerns the work to which you have testified, is it not true that you devoted your attention to the use of silver as a catalyst for the production of ethylene oxide? A. Yes.

Q. Over that same period, however, were you concurrently conducting experiments on other materials or other processes for the production of ethylene oxide? A. Will you please repeat that first date?

Mr. Watson: February, 1935, to November, 1936.

A. Yes, yes, during that period we investigated other processes.

Q. In the fall of 1935 were you informed that the Distillers Company, Ltd., of England was operating this Lefort process with silver? A. No, sir, I was not.

Q. When did you get word that the Distillers Company of England was using silver as a catalyst in the process of making ethylene oxide from ethylene and air? A. I have never received word from them that they have used silver.

Q. Were you informed in the fall of 1935 that the Distillers Company owned the British patent rights to the Lefort process? A. Yes, some time late in 1935, I think it was.

Q. Are the records which you have given us of the work you conducted from February, 1935, to November, 1936, all the records of the work you did with silver in this process and, if not, may we consider them as typical? * * * [630-634].

* * * A. It is typical, certainly, of the period over which you have been given these records.

Q. In February, 1935, you made a test using silver gauze, is that correct? A. No, I did not personally make that test. I know of that test.

Q. How many men were under you? A. At that particular time?

Mr. Watson: Yes.

A. No one was working under me at that particular time.

Q. Well, who conducted those tests on the silver gauze? A. Mr. Fogg.

Q. Do you recall there were two of them? A. Two silver tests?

Q. Two gauzes? A. There was one copper and one silver.

Q. One silver, and there were platinum? A. Platinum.

Q. On the first page of Exhibit 25 there is a note that for maximum activity you anneal the platinum gauze for one hour. Was the purpose of that treatment to make the surface of the gauze more catalytically active? A. We did that in accordance with the instructions of the people from whom we purchased the platinum gauze, and that was the reason for so doing.

Q. That is, the reason which I have stated? A. Yes.

Q. The general procedure for the purpose of improving the surface of the gauze to make it more catalytically active by an appropriate pretreatment was well known to you at the time? A. That particular one, I think, was not well known to me at that time.

Q. Well, you broadly stated the desirability and procedure, suitable procedure, of pretreating the silver gauze to render its surface more catalytically active, that is to render it into finely divided form, was commonly known, wasn't it? A. Yes, I knew of the fact of finely divided silver.

Q. Do you recall why you failed to use any such pretreatment with the silver gauze in these experiments although you did use it in the employment of platinum? A. The pretreatment was given the silver gauze.

Q. Is that indicated in your notebook? A. I don't think it is indicated in the notebook.

Q. You mean you think it is not indicated in any of the records which you have given us? A. Most likely it is not. I am not sure of that but I don't think it is.

Q. Were you familiar generally with the article by Bone and Wheeler which gave a description and picture of silver gauze to increase its activity for catalytic use? A. I don't remember whether I was familiar with it at that time or not.

Q. In the test on silver gauze in Exhibit 25, your records give a sketch of the apparatus. Are we to understand that you used one layer of silver gauze across the catalyst tube; in other words, clamped between flanges of the pipe and then merely passed the gas mixture through that layer, through the spot, whose dimensions you have given as about the size of a nickel, a five cent piece? A. I think yes, that is correct.

Q. Do you recall that in this silver gauze experiment you made no test for carbon dioxide in the exit gases while the temperature of the silver gauze was as low as 400 degrees Centigrade? A. I don't recall that.

Q. Will you please turn to that Exhibit 25 and tell me whether as far as that notebook is concerned it is not true that there is no test for carbon dioxide as low as 400 degrees? A. What is the page, please, Mr. Watson?

Q. The last page, I think, of that exhibit. I think only the last page and perhaps the first relate to silver. The balance is platinum? A. No, no indication of carbon dioxide appears there.

Q. So as far as the records indicate, you could not tell whether any reaction was occurring between the ethylene and air at temperatures below 400 degrees? A. There is one gas analysis recorded, there are two gas analyses recorded here, one is above 400 and the other, no temperature is recorded in the preheater, the preheater was cold.

Q. Before you undertook this February 1935 work, did you familiarize yourself with the literature on the subject of known methods of making active silver catalysts? A. I had started to. I was not entirely familiar with it at the time this was done.

Q. Were you fairly familiar with it when you returned to work on this general subject in December, 1935 and February 1936? A. I was more familiar with it.

Q. You were what? A. I was more familiar with it.

Q. Did you at that time find that one commonly regarded method of such a preparation was by taking silver nitrate and precipitating silver oxide and then reducing it with hydrogen? A. Yes.

Q. After your February work, is it not true that as far as your records are concerned, your next test was in December of that year? A. Yes, the next test.

Q. And that was the test on silver rivets? A. That is correct.

Q. What was the size of those rivets? A. I don't remember the exact dimensions. They were about three-sixteenth inches long and the body of the rivet about three-thirty-seconds of an inch. They were quite small.

Q. In Exhibit 27 which concerns your silver rivet experiments, you obtained some ethylene oxide, did you not? A. I did.

Q. And you produced that product even though the temperature through the catalyst bed was by no means uniform, is that true? A. That is correct.

Q. In that experiment also, I think you stated or your notebook records the fact that about two-thirds of your silver rivets had been previously used and had a mat surface. Now, if the other third had had a similar surface, wouldn't the tendency have been to produce more ethylene oxide? A. That, I cannot state for a fact because I never used entirely new and previously unused silver rivets.

Q. As to the later tests reported, are we to assume that all the notes in the notebook were entered on the dates they appear? A. Unless it is stated to the contrary.

Q. Please refer to Exhibit 36. Apparently there is some slight discrepancy there which I wish you would clear on the first page; that is page 77, which is dated June 25, 1936. It refers to the operation and speaks of the catalyst employed, as I read it, E-44, whereas on pages 87 which seems to be with reference to the preparation of that catalyst, it appears that the date was October 17th, 1936, several months later? A. That is hardly possible that that could be a catalyst made in October and

tested in June. I expect that is an error in reporting the facts in the notebook.

Q. I agree with you that there is an error of some kind of course. I wonder whether that may indicate that the catalyst numbers in these reports were entered in the notebook at later dates? A. Not that late. Sometimes we would make one catalyst, it might be made today and entered in the book the next day.

Q. Well, then, you have no explanation for this obvious error? A. No, it might be worth while to look through the catalyst book and see whether the dates would not eliminate that. It was just an error.

Mr. Barrows: Will you look through the catalyst book you refer to and see what page you find that on and what the context is?

The Witness: Well, the two preceding entries, one for E-42 that was made June 15th, 1936, and E-43 was on June 16th, 1936 and E-44 bears the notation October 17, 1936 and the one on the next page is October 18, 1936, both in my handwriting, and then drops back to June 23, 1936 and then goes on to June 24th. I think I must have labored under a misapprehension as to months when I wrote that.

Q. Under whose direction or at whose request were all these tests run? A. Why, in the main at the request of the head of the laboratory.

Q. Who is that? A. Doctor Metzger.

Q. Exhibit 32 mentions they were made at the suggestion of Mr. Balcar. Who is he? A. I believe he bears the title of assistant chief chemist for the Air Reduction Company.

Q. And Mr. Carter, who is Doctor Metzger, so we can have him identified? A. He is in charge of research and development for the U. S. Industrial Alcohol Company and vice president of the Air Reduction Company in charge of research and development for that company.

Q. He has been in the Court room during the trial? A. I believe he has.

Q. By the way, where did you receive your doctor's degree? A. I haven't. I did not so testify. You have been calling me Doctor.

Q. You did not want to take advantage of me? I merely adopted the terminology by which you have been addressed by your own counsel? A. I gave my counsel correction that appeared in the record in that respect. I don't know whether he has given that to you or not.

Q. No, he hasn't. A. That will appear in due course of time, I am sure.

Q. In your direct examination, I understood you to tell the Court despite all of your efforts you had been unable to find a satisfactory catalyst for reacting ethylene and air to produce ethylene oxide before September 1936. Is that the impression you wish to convey to the Court? A. I don't know that those are my exact words but that is certainly the sense of what I would have meant. Up to that time I had not found a successful catalyst for the commercial production of ethylene oxide from ethylene and oxygen.

Q. Well, you mean up to that time you had not found a successful process; that is, a successful catalyst for use in demonstrating the operativeness of the process for producing ethylene oxide without aldehydes by passing the mixture of ethylene and air over the catalyst? A. The commercial operativeness, do you refer to the commercial operativeness? We had not yet discovered a catalyst. We were able before that time to make small amounts of ethylene oxide.

Q. What do you mean by small amounts? A. Oh,——

Q. Are you speaking in pounds or gallons, quarts or percentages? A. I mean amounts which would appear to be too small for commercial operation.

Q. Well, of course, the amounts involved, the amounts produced, I assume, depend a good deal on the size of your apparatus, and how long you conduct the operation; is that true? A. Well, we would judge that largely on the percentage of ethylene converted to ethylene oxide, regardless of the size of the apparatus.

Q. So what you intended to give the Court the impression of was that until November, 1936, you had not been able to find a silver catalyst that would effect the conversion of the ethylene into ethylene oxide at a high enough efficiency or yield per pass. A. High enough to be satisfactory for commercial use, that is correct.

Q. And what figures on conversion and efficiency do you wish us to understand, so that we can understand what you mean by saying they were not commercially satisfactory? A. I don't know that I can give a single figure which would satisfy that requirement, because the commercial success would depend upon some other factors besides the mere conversion. But certainly one ought to have a conversion of, let us say, 30 per cent., or better, I should imagine, in order to envisage commercial use.

Q. And that is single pass yield? A. I understood you to ask about conversion now. By yield, do you mean what I mean by conversion?

Q. Well, define your word "conversion"? A. I defined the word "conversion" the other day by saying it was the percentage of ethylene fed into the apparatus which appeared as ethylene oxide as an exit product.

Q. How would you define the word "efficiency?" A. Well, I have usually in my notebook, I have used the word "yield" as a rule instead of efficiency, meaning the percentage of the ethylene consumed, which has appeared as ethylene oxide.

Q. You call that yield? A. I call that yield.

Q. And what would that percentage be, within your present definition of satisfactory for commercial purposes? A. That would vary somewhat. Probably it would vary between limits of, let us say, 45, 55, 60 per cent.

Q. Well, then, are we now to understand that long before November, 1936, you had obtained silver catalysts satisfactory for conducting this process, when we define the word "satisfactory" by saying that it proved the operativeness of the process? A. You have not sufficiently yet defined the word "satisfactory," I don't think.

Q. Well, I will make it— A. I can not answer that question "Yes" or "No" until that point is clear.

Q. Did you want to give the Court the impression that not until November, 1936, were you able to get a silver catalyst which you used in your laboratory tests, and over which you passed ethylene and air, at a temperature between 150 and 400 degrees, to obtain ethylene oxide in yields up to 40 per cent.? A. Well, the one other point which makes the catalyst operative commercially would be that those yields would be maintained at a reasonable figure.

Q. Well, that does not apply. I have excluded what you have called commercial operations from my question. I am asking you now whether for informative purposes of teaching a skilled chemist how to conduct this process of passing ethylene and air over a silver catalyst, within the temperature range stated, from that viewpoint, had you done nothing before November, 1936, to satisfy you of the operativeness, to demonstrate the operativeness of the process? A. If you define the operativeness of the process as a production of a substantial and economic amount of ethylene oxide, we had not. Defined as those——

Q. All right, your term has been 45 to 55 per cent. yield. Now, before then had you obtained 44 per cent. yield? A. I don't remember whether we had or not. I would have to look up the records to see whether those figures are * * * [634-649].

* * * Q. Will you refer, please, to Exhibit 31? That is a group of summary sheets on your experiments with silver on pumice, is it not? A. It is.

Q. Is it not true that in the experiment of February 18th, the fifth day, at a temperature of 310 to 322 degrees Centigrade you noted you were obtaining a yield of 15.8 per cent.? A. Page 8?

Mr. Watson: Yes.

A. I do not seem to see it. 322 degrees? I just can not seem to find the particular records to which you refer.

(Mr. Watson indicates to the witness.)

The Witness: Oh. 15.8 per cent.? I understood you to say 50. Yes.

Q. That yield was 19.8. Excuse me. Wasn't it? A. 19.8, yes.

Q. And the consumption was 25 per cent.? A. That's correct, that's what is stated.

Q. Can you calculate what the efficiency was from those figures? A. Yes, if you divide 24 into 19.8.

Q. That shows an efficiency of 82½ per cent., doesn't it? A. Approximately.

Q. Well, we will take that subject to your correction later on, if you wish. A. It is approximately correct.

Q. In the same exhibit on the eighth day, apparently beginning March 24, you were obtaining at 322 degrees a yield of 35.9 per cent.? A. March 24 the eighth day appearing in this tabulation? Not 35, no.

Mr. Watson: No, that is the eight day test, but it is the fifth day I am referring to.

Mr. Barrows: What date is that, Mr. Watson?

Mr. Watson: March 24.

A. 35.9.

Q. And that efficiency was about 69 per cent., wasn't it? A. It would be roughly that, yes.

Q. And the sixth day the yield was 29.2 per cent.? A. Conversion 29.2.

Q. Well, that is conversion to ethylene oxide? A. Conversion to ethylene oxide.

Q. And the percentage consumed was 52? A. That's right.

Q. So the efficiency was about 56 per cent.? A. Yes.

Q. And on the next day the conversion was 33.2 per cent.? A. That is correct.

Q. And the per cent. consumed was 52 per cent.? A. That's right.

Q. And the efficiency, therefore, was about 64 per cent.? A. It would be a little less than 64.

Q. Well, 63.9, was it not? A. Yes, about 64.

Q. And on the eighth day the per cent. of conversion was 31.8, per cent. consumed 64, which would give an efficiency of about 50 per cent.? A. Yes.

Q. And the third day you had per cent. conversion of 37.7 and a per cent. consumed of 60, which would give an efficiency of about 63 per cent.? A. That would be right.

Q. Well, now, we can calculate the efficiencies in all these cases by the mathematics you just explained, can't we? A. Yes.

Q. I mean I do not want to go over all of these figures with you, because they are in the record and we can make our own calculations for efficiencies? A. Yes, you can calculate those.

Q. Well, then, it appears in this very first group of tests when you used silver on a support over a period of a week's operation or longer you were getting ethylene oxide yields, conversion per cents. of over 30 per cent., consumption figures over 50 per cent., and efficiencies over 50 per cent., is that right? A. Correct.

The Court: Well, now, why did that not satisfy you? The answer to that question I would be interested in.

The Witness: The answer to that is we could not repeat those with silver on pumice and get these results.

The Court: You mean it was not a question of getting isolated satisfactory results but continuous operation?

The Witness: That is just it exactly. We would make up another catalyst in the same fashion and we would not necessarily get the same results at all.

Q. Well, did your repeated tests prove the point you just made: that you did not get continuous satisfactory results? A. Yes.

The Court: With the same catalyst?

A. Yes.

By Mr. Watson:

Q. Well, do you mean that literally, Mr. Carter? That if you took the same support material, put on the same silver catalyst in the same way, you would not get duplication of results? A. That certainly was true with some of the early work with pumice.

Q. Well, was that because of deliberate variations in your procedure of putting the silver on the pumice? A. No. No, that does not follow.

Q. Was it because of deliberate variations in the amount of silver deposited? A. No, those results would have——

Q. In this particular instance with the pumice don't you explain it and didn't you explain it to yourself at the time as the result of a rather miscellaneous assortment of pumice? A. A miscellaneous what? I beg your pardon?

Q. Assortment of pumice. Didn't you think the variance of results followed from variations in the pumice? A. I don't see how that could possibly have been. We tried various lots of pumice. I do not think the difference arose from the variation in the particular lot.

Q. Let me ask you this general question on this subject, then: As the result of this first week's test of silver on pumice, when you got the yield which you have indicated and the efficiencies which you have indicated in the production of ethylene oxide, weren't you satisfied in your own mind at that moment that it was possible to make a silver catalyst which under this process would directly combine ethylene and molecular oxygen to produce ethylene oxide without substantial aldehyde formation? A. That is true if you do not limit the amount of ethylene oxide formed. We made ethylene oxide. The records show that.

Q. And it is true if you do not limit it in the per cent. beyond the figures recorded in your records? That is also true, isn't it? It seems to me it is inescapably true. A. The figures recorded in the records show that after about eight or nine days' operation the activity expressed by conversion had fallen from a maximum of

37.7 to a minimum of 30.7. That is 7 out of 31, or a 20 per cent. loss.

Q. Now, I will have to have an answer to my question. As of that date you were thoroughly convinced, were you not, that it was possible to make an active surface silver catalyst over which you could pass ethylene and air at a temperature within the range we have spoken of and produce ethylene oxide in substantial percentages with satisfactory efficiencies? Isn't that true? A. That experiment led us to think that it would be possible to do it.

Q. Well, more than that, that experiment led you to believe that you had done it, didn't it? A. No. No.

Q. Did you refuse to credit your own figures? A. These figures were perfectly good as far as the initial activity of the catalyst was concerned, but that 14 per cent. drop in conversion over a period of nine days led us to believe that the thing commercially would be of no success. Therefore, we continued the experiment.

Mr. Watson: Well, I will let the records speak for themselves.

Q. Please turn to Exhibits 21 to 23 dated about the 7th of May, 1936. Here you added sodium hydroxide to form silver oxide, is that right? A. Yes.

Q. And your summary says that after the precipitation by sodium hydroxide the catalyst was washed with an alkali. That is your summary, isn't it? A. That's the way it reads.

Q. The notebook statement indicates the contrary, doesn't it? A. Whereabouts?

Q. Page 37 of Exhibit 22 shows that the mass was washed with water only until no alkali could be tasted, doesn't it? A. I don't seem to have the page——

Q. Page 37 of Exhibit 22? A. I think that is tested.

Q. How can it be that when the notes go on to say that the wash water turned litmus blue, which does show that alkali was still present, doesn't it? A. Yes, and that is followed by the statement here that it had a dark opalescence, which looked like silver that had been reduced by light.

Mr. Watson: I will ask defendant's counsel if he will agree without calling a handwriting expert that the word is tasted.

(Discussion follows at the trial table.)

Q. I hand you the original notebook about which you have previously been examined from a photostatic copy. Is this in your handwriting, page 37? A. That is.

Q. Well, now, don't you think the word on line 8 is tasted? A. I think that is, it is much clearer than on the photostat.

Q. Now, what was your answer on what was proved by the fact that the wash water turned litmus blue? A. I called attention to that but you had not completed the sentence.

Q. That proved, didn't it, that there was still alkali present? A. Yes, that proved that there was alkali present.

Q. It would have been a simple matter to make sure that all of the alkali was removed from the silver oxide by first precipitating the silver oxide from the nitrate, then washing the precipitate thoroughly and then mixing a slurry of the precipitate with infusorial earth, isn't that true? A. It could have been done in that way, yes.

Q. By the way, you saw the demonstration conducted two weeks ago at South Charleston? A. I did.

Q. And you saw how that silver was prepared on the carrier? A. Yes.

Q. That was a simple, normal, obvious procedure, wasn't it? A. Yes, it was very carefully prepared.

Q. And it was a simple, obvious way to do so? A. It was a simple way, yes.

Q. Well, it was an obvious way in that it had been taught for fifteen years or more, isn't that true? A. It has never been taught me for fifteen years to put 32% silver on filtros.

Q. But the procedure followed? A. The procedure of precipitating the silver you referred to?

Q. Yes. A. That is a perfectly normal procedure.

Q. Everything was normal then except the amount of the silver? A. The method of precipitating the silver was perfectly normal.

Q. Was everything else about it perfectly normal and well known in your opinion except the amount of the silver? A. Well, I wasn't familiar with that choice of support.

Q. Suppose we use carborundum. You are familiar with such a support? A. Carborundum?

Q. Yes. A. Yes, I think I have made a catalyst on carborundum.

Q. Did it work? A. My recollection is it did not work well.

Q. Then with the possible exception of the particular inert carrier filtros and the amount of the silver, 32% or whatever it was, you think everything else about it was well known, common, usual procedure of preparing a silver catalyst on a support? A. Yes, I think it probably was.

Q. And your answer would be the same when we put the date say ten years back? A. I am not so certain of that because I don't just recollect just what the state of the art was exactly ten years ago.

Q. Well, you are familiar with the Benton and Elgin disclosure of how to prepare an active surface silver catalyst? A. I have read that, yes.

Q. And that is dated— A. I don't remember the exact date, about 1930 or thereabouts, I think.

Q. Now, in three of your experiments you used silver oxide, didn't you? A. We used silver oxide. I don't remember whether it was exactly three.

Q. Four of them, I believe. Refer to Exhibit 31, the sheet dated March 16th. Here you added silver nitrate solution to nitric acid washed pumice? A. Yes, sir.

Q. And you evaporated it to near dryness and then added sodium hydroxide? A. That is true.

Q. The mixture was washed and your records show the wash still indicated the presence of unreacted silver nitrate, is that correct? A. Yes.

Q. In Exhibit 32, comprising pages 180 to 182 of your notebook, that does not tell us, I believe, how you made your silver oxide, is that right? A. Apparently not.

Q. You used it, however, in such a way that the catalyst got pretty well channeled, is that correct? A. It was of very short depth, I remember that.

Q. And your experimenter noted in his records, did he not, that it was hardly a fair test on that account? A. That is correct.

Q. Nevertheless you got 4.3% conversion of ethylene oxide, didn't you? A. Yes.

Q. Now, refer to Exhibit 34. Here you make silver nitrate with chemically pure aluminum silicate and precipitated the silver oxide with sodium hydroxide wash, is that right? A. That is right.

Q. Was your aluminum silicate fused or fritted into active form? A. Aluminum silicate?

Q. Yes. A. That was bought, I think, from—it was a C. P. product. I know nothing about it other than that it was finely powdered, that is all I know about it.

Q. You don't know whether it had been subjected to high temperature? A. I don't know anything about that.

Q. The pumice you used as supports, however, was in a prefused form? A. The natural form in which it came to us.

Q. What was that form? A. Crushed to about quarter mesh size.

Q. It had not been fused? A. My understanding of pumice is that it is a product of nature which at some time has been fused.

Q. In other words, naturally it has been subjected to a high temperature before it is going to be subjected to use as a support, is that right? A. As far as I know it is.

Q. At that time had you consulted the literature to find out whether activated alumina, for example, destroyed ethylene oxide at the temperatures involved in the use, at 150 to 400 degrees? A. Destroyed ethylene oxide?

Q. Yes. A. No, I did not try specifically for ethylene oxide.

Q. I say at that time had you examined the literature to find out whether that was a fact? A. Yes, activated alumina? No, I never had examined the literature for that.

Q. Did you ever examine the literature to see whether that was a characteristic of silica gel also? A. To decompose ethylene oxide?

Q. Yes. A. No, I don't know anything about that.

Q. Have you received information in any fashion to acquaint you with the fact that such activated alumina or silica gel within the language of activities we have been dealing with was not inert; that is, it did act to destroy, to transform ethylene oxide into acetaldehyde? A. No, I received no such information.

Q. What is your opinion on that? A. I have never tried that particular experiment. I do know that both these are inert as far as the oxidation of ethylene is concerned.

Q. Of course, they would not be inert in this process, would they, if they were active in their own right to destroy the very product which you desire to obtain in the reaction? A. No, if that is the case, I don't know that that is the case.

Q. When you undertook this work, did you consult the literature as to suitable supporting material? A. I don't remember consulting the literature, no. I think I depended largely on my own knowledge.

Q. And your own knowledge included a knowledge of the desirability of using an inert support? A. Inert, as far as the combination of the support and silver was concerned, the support and catalyst.

Q. And it included the knowledge of the obvious desirability of using a support which would have some mechanical strength; is that right? A. That would be necessary, yes.

Q. And that support should have a surface to which the catalyst silver could adhere well; is that right? A. That would be an essential to a good catalyst, yes.

Q. And you knew that it was obviously desirable to use a support so that your finished silver catalyst would be, say, in granular or broken pieces, so that the gas flowing through the catalyst bed would be well mixed, and would not channel its course through the bed. A. Yes.

Q. In June, 1936, your records show that you did some work on silver tartrate. Do you recall that? A. Yes, I do.

Q. Please refer to Exhibit 39, which is your summary sheet dated as of June 11, 1936 (exhibit handed to witness). In this test you attempted to decompose this tartrate to silver by heating it on an old unglazed plate; is that right? A. It was an unglazed plate, I don't remember the old. It may have been.

Q. The note says "old," doesn't it? A. It says "old" here.

Q. As far as the notes indicate, there might have been something on that old plate which might have poisoned the silver as a catalyst? A. Well, the notes don't so indicate.

Q. They don't exclude that possibility either, do they? A. No.

Q. No. Your method of preparing that silver catalyst was simply by putting it on this old unglazed plate, in the open air, over a Bunsen burner. Is that right? A. Correct.

Q. Is it not true that the experimenter's notes indicate that the heat necessary to decompose the tartrate was so strong as to render the catalyst relatively inactive? Page 104. A. He suggested that that might be one cause for its inactivity.

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Q. At that time didn't you know other silver compounds which would decompose under lower temperature than the tartrate? A. Yes, I believe that at that time I tried oxalate. I don't know just what its temperature of decomposition is. But it is probably a little lower than the tartrate.

Q. You have not, however, produced such records among those presented here? A. Well, I was unfortunate in that respect. I could not seem to hold silver where I could use it thereafter.

Q. Is it not true that in your experiments conducted after about the first of May, 1936, your results tended to go down hill? A. In what respect do you mean, Mr. Watson? Do you mean in respect of conversion.

Q. Yields and efficiency? A. I was not aware that it was a matter of time. We may have been using certain catalysts and certain supports which would have resulted in that, but I would have to look them over to see whether they fall in that date or not * * * [656-677].

* * * Q. You spoke in your direct examination of about 40 supports you tried, and I think your records indicate or show about a dozen or so. Do you want to give us a list of the remainder A. That list of 40 went up to the time of the present. I answered his Honor on that matter, and that included, those included some that have been made recently.

Q. I see. So that the only ones you had used up to November, 1936, were those that are already in the record? A. I think there may be some others that are not included in the record, but it would be a relatively small number.

The Court: Well, it is only about twelve in place of forty?

The Witness: Forty are the ones that have been used altogether.

The Court: But up to November?

The Witness: Up to November I do not recall the exact number but——

Mr. Fairbank: I would say about a dozen would be about right.

The Witness: About a dozen would be about right * * * [688-689].

* * * * * *

Thereupon——

RAY M. CARTER, a witness recalled by the defendant, testified further as follows:

DIRECT EXAMINATION.

By Mr. Barrows:

Q. Mr. Carter, during your prior examination, you described experiments made with the silver on pumice as a catalyst and extending over a period from February 1, 1936, to the latter part of May and in your note book record of May 28, 1936, Defendant's Exhibit 24, you summarized your work up to that time and outlined further items of investigation. Did you continue your work on a silver on pumice catalyst after May 28, 1936? A. I did.

Q. How long did you continue your work with the silver on pumice catalyst? A. That work was continued until near the end of November, 1936.

Q. What was the nature of that continued work? A. That work consisted of a continuation of a study of the method of preparation of a silver on pumice catalyst. Studies were made of the method of deposition of the silver, the amount of the silver and the method of reduction of the silver compound. Attempts were made to prolong the life of the catalyst by various means of revivification, and in general to improve the operating conditions with this kind of a catalyst.

Q. During this period from May to November did you try other catalysts than silver on pumice? A. Yes, we tried silver on various other supports than pumice.

Q. With what results? A. Several supports gave catalysts which produced little or no ethylene oxide. None of them appeared to be as good as pumice.

Q. Why were you concerned in trying various supports for the silver? A. The silver on pumice catalyst required a high percentage of silver, around fifty per cent. for best results. We realized that it would not be feasible to use a straight silver catalyst without a support in a commercial process and that it would be necessary to use a supported silver catalyst. We hoped to find a better support than pumice on which a lower percentage of silver could be used and which would have a longer life and a higher capacity for production of ethylene oxide than the silver on pumice catalyst.

Q. How did you control the temperature in your experiments on the silver on pumice catalyst? A. Up to the early part of September we used an electrically heated apparatus and controlled the temperature by regulation of the electric current. We also used an apparatus in some experiments where the reactor was immersed in a fused salt bath. Early in September we installed a small reactor with a jacket surrounding it containing diphenyl oxide. This was installed to give better heat control along the lines which would be used in eventual commercial operation.

Q. What followed the use of the silver on pumice catalyst in November, 1936, and what was the reason for discontinuing the use of such catalyst? A. In November, on checking back over the various carriers or supports that had been tried to see if any of them offered promise for further investigation and as possible improvements on pumice, I found that the best results previously obtained with any other carrier was with alundum back in July and I started to make a further investigation of this material as a catalyst support.

Q. With what result? A. This support for the silver proved to be so much better than pumice that further work with pumice was stopped and we made rapid progress from that time on in our development work.

Q. What advantages did you find the alundum carrier to have and what progress did you make from that point on in your work? A. We found that much less silver was required on the alundum support than on pumice and with ten per cent. of silver on alundum

we obtained radically better results than we ever had obtained with the pumice carrier. We found that the productive capacity of the catalyst was far greater than could be obtained with pumice. A greatly increased flow of gases and a greatly increased production of ethylene oxide could be obtained. We found that the catalyst did not deteriorate with age as did the silver on pumice catalyst and maintained its high activity for a long period of time. With the decreased amount of silver required, the greatly increased production capacity and the long life of the catalyst, we realized at once that we had found what we had been hunting for and had a commercial catalyst. From that point on, progress was rapid.

The apparatus built and used early in September, 1936, and which had a diphenyl oxide jacket for temperature control was one-half inch in diameter and four feet long. Early in December we installed and operated a similar tube sixteen feet long and later in December, 1936, another tube two inches in diameter and sixteen feet long, both being provided with a diphenyl oxide jacket for temperature control. These tubes were designed to obtain operating data for use in designing a larger scale pilot plant. In January, 1937, we installed and operated another converter with a tube one inch in diameter and sixteen feet long. During April, 1937, the production obtained from the two-inch tube unit was at the rate of about fourteen pounds per day with a yield of about 65 per cent ethylene oxide.

In April, 1937, plans were started for a larger pilot plant containing twelve tubes, two inches in diameter by sixteen feet long, and at the same time preliminary plans and estimates were started on a commercial plant, based on the results that had been obtained on the single tube unit.

Q. Did you take steps to protect by patent the production of ethylene oxide with the use of the silver on alundum catalyst? A. Yes. A patent application was filed for the production of ethylene oxide with this catalyst on May 8, 1937, serial number 141422, which matured into United States Patent 2,125,333 on August 2, 1938.

Q. Will you briefly summarize your work on the production of ethylene oxide with the use of a silver catalyst prior to the middle of May, 1937. A. Throughout the year 1936 and up to that date we had carried out an extended investigation of the process, investigating numerous silver catalysts and had succeeded in discovering and developing a satisfactory silver catalyst with alundum as a support or carrier. Except for a few experiments, the process was carried out with the use of a mixture of ethylene and air and without the addition of water to the gaseous mixture passed over the silver catalyst for the production of ethylene oxide therefrom and at temperatures generally between 250 and 350 degrees C. Except for isolated experiments, hydrogen was not admixed with the gases. The commercial catalyst which was developed of silver on alundum as a support and the results obtained with this catalyst were such that rapid development work had taken place and at the time referred to, the middle of May, 1937, plans for a larger pilot plant were under way as well as preliminary plans and estimates for a commercial plant.

Cross Examination.

By Mr. Watson:

Q. In your direct examination it was not your intention to contradict any of the statements of the witness, Adams, was it? A. My direct examination was made before it. I had no notion——

Mr. Watson: This one (indicating statement), this examination right here.

A. Oh, that one? No, sir.

Q. Your statement, so far as there may be discrepancies between this and Mr. Adams' statement, may we not prefer his? A. I do not know that there are any discrepancies there.

Q. I am asking you, however, if there are, may we not take his word? A. You can take whichever word you choose; I have nothing to say about what choice you should make as to that.

Q. In one of these answers you said that you realized it would not be feasible to use a straight silver catalyst. Was that for financial reasons? A. That was for two reasons: we felt that the use of a straight silver, unsupported silver catalyst, would be much more expensive than the supported silver, and, in the second place, we felt there was a possibility that unsupported silver would deteriorate at a faster rate than supported silver.

Q. Did you ever make tests on silver pellets? A. Pure silver?

Q. Yes, up until this time, that is, the date you are referring to, November, 1936? A. Not silver pelleted in the sense, I think, that you refer to. We had used silver made from silver oxide.

Q. And up until November, 1936, your experimental apparatus had been on a size no larger, perhaps not so large, as Plaintiff's Exhibit 3 in the courtroom, is that correct? A. (After looking at Plaintiff's Exhibit 3) It was about the same length but with somewhat smaller diameter tube, in the case of one of the pieces of apparatus; others were essentially of the same diameter.

Q. The patent you referred to suggests the use of silver up to 50 per cent by weight, does it not? A. It may be up to 50 per cent by weight.

Q. You speak here of production in a two-inch tube yielding about 65 per cent ethylene oxide. You mean that was the efficiency? What we have termed efficiency in the testimony? A. That is what we call yield and I believe that is what you term efficiency.

Q. And you say throughout the year 1936 and up to the middle of May, 1937, you carried out extended investigation, and so forth. In all that work was water present in the reaction zone? A. Water was not added.

Q. Answer the question, please. A. Water was present to the extent that it was in the air, which was fed to the apparatus.

Q. And to the extent also that it was formed in the reaction zone? A. That is correct.

Q. Is Dr. Metzger the technical director of the defendant? A. Yes.

Q. And he was acquainted with all your work during this time and was in a position where he perhaps best knew the program? A. Well, he was acquainted with the work, yes.

Q. And he has been in court throughout the trial? A. Yes * * * [1317-1328].

* * * * * * *

TESTIMONY OF CHARLES E. ADAMS.

Thereupon——

CHARLES E. ADAMS, a witness on behalf of the defendant, having been first duly sworn according to law, was examined and testified as follows:

Direct Examination.

By Mr. Edmonds:

Q. What is your place of residence and your official capacity? A. 4 East 72nd Street, New York City. In connection with this suit I am Chairman of the Board of the U. S. Industrial Alcohol Company and the U. S. Industrial Chemicals Corporation, Inc.

Q. What is the relation of those two companies? A. The U. S. Industrial Chemicals, Incorporated, is a wholly owned subsidiary of the U. S. Industrial Alcohol Company.

Q. What is briefly the reason for having the two separated? Is it something that grows out of the— A. Something that grows out of the structure of the two companies. The Alcohol Company started as a distiller of industrial alcohol. There are any number of restrictions surrounding an alcohol plant. The Government has inspectors all over the place. You are confined in your activities, so we formed the chemical company and brought the alcohol around to the chemical company to make further derivatives and then there were certain tax reasons for changing the capital structure and finally

there developed from that the U. S. Industrial Alcohol and the U. S. Industrial Chemicals, which is a selling and a chemical manufacturing company——

Q. Now, will you state what is the nature of the business of the alcohol company and what it was in 1904 and in that connection you may refer, if you will, to the use of ethylene glycol as an anti-freeze? A. The U. S. Industrial Alcohol Company started as a manufacturer of industrial alcohol. At the time industrial alcohol was declared tax free as distinguished from alcohol. Out of that developed the chemical enterprise which was based on the derivatives of alcohol in the beginning but over the years from 1904 to 1927 when I became connected with the U. S. Industrial Alcohol Company and from then on to the present, a very large proportion of their alcohol business was in the anti-freeze field. That is, ethyl alcohol was used as an anti-freeze medium in automobile radiators in the cold weather. From the time when I became intimately acquainted with the business in 1927, I would say 40% of the volume of industrial alcohol made by the company went into automobile radiators as an anti-freeze.

In 1927 the production and sale of ethylene glycol as a so-called permanent anti-freeze was relatively unimportant. It was just beginning. By the time 1933 rolled around our best observation was that ethylene glycol had taken about 14% of the business away from ethyl alcohol. We were obviously very much interested in having an ethylene glycol supply of our own to supplement ethyl alcohol as an anti-freeze. Ethyl alcohol will always have a big volume because it is a cheaper product and the man that hasn't the money to pay to charge his radiator with ethylene glycol in the beginning will take a chance that he will not have to charge it too many times with ethyl alcohol and that is always going to be a big volume, but we want them both. Do you want me to go on from there with the history of our development?

Q. Yes, if you will. A. Toward the end of 1933 we had a survey brought right up to date as to the proportion of business then enjoyed by ethylene glycol. We had a report made by one of our research men and that report indicated that there was no reason why we could not

develop a perfectly workable process for making ethylene glycol by the old fashioned chlorine method, but advised us very strongly against that on the ground that for twelve or fifteen years people had been working toward the direct oxidation of ethylene, and if we had a direct chlorine supply of our own and transferred the chlorine from its source of manufacture down to our plant, and made ethylene glycol, we would have an investment in what he told us would be an obsolete plant in the course of the next five or six years. So we determined at that time to start a real research program on the direct oxidation of ethylene and started spending money with that in view in January, 1934.

Q. What was the program initiated at that time and how did you follow through? A. That research problem was, as usual, given a number and assigned to the laboratory at Stamford, where we have some fifty-five research chemists in the employ of the Air Reduction Company and U. S. Industrial Alcohol. The expenses of that laboratory are borne jointly on a pro rata basis as indicated by the work done by each company over a period of time. It might have changed from time to time but it runs pretty even for forty per cent of the expenses going to the Alcohol Company and sixty per cent going to the Air Reduction Company.

Orders were given to throw the throttle wide open with full steam ahead to solve this direct oxidation of ethylene as soon as possible. Some of the best men we had were assigned specifically to that work and from that time on until we started construction of our commercial plant in midsummer of 1938 approximately, they were never off from that subject.

Q. At an early stage on that, did you do anything in the way of arranging to keep a supply of current literature of the subject coming in? A. It was already automatic, beginning in 1916 when the Air Reduction Company was formed and we started the Research Department, such machinery was set up so that every current chemical paper was brought to the attention of our experts and they followed all the patent applications from all the countries that have patent laws and received the reports and patents as issued, so that anything that we

were interested in, anything that was a related research problem or that the librarian, we will call her. in charge of that particular bureau, thought was related to what we were interested in, that was immediately sent for, brought in and read and turned over to the research man who was most closely related to that subject.

Q. Did the operation of that established system result in bringing before your people the French Lefort patents? A. Yes, indeed.

Q. Were they examined at the time? A. Yes.

Q. Did anybody find anything of interest in them? A. Not at all. That was reported in February, 1934, as I remember the first one.

Q. And the others came along? A. The others came along just as soon as they were issued.

Q. Will you trace the course of the research work, what was done, how it progressed, with what vigor it was advanced, and the period of time it covered? A. Well, it was pressed with all the vigor that they could press it. It had its up and downs like all research problems do, all which I have ever had any experience with. It was not until the end of 1935 that we began to get pretty well encouraged. Somewhere in the very early spring of 1936 we had achieved such results that we were in our own minds, I say in our minds, I had no mind on the subject, it was the research men that had the minds, but in their minds they felt we could sit down with patent counsel and outline the road that we expected to pursue and the goal that we hoped to reach as the result of following that.

Q. Did the research work cover research in both catalytic and non catalytic processes? A. Oh, yes, it covered them.

Q. Did the research cover catalytic operations, both with and without water? A. Yes.

Q. Can you state approximately, or at least by way of limitation at what time you had definitely discarded the idea of admitting the water to the reaction chamber, and from which time you went on using only the ethylene

and air reactions? A. I can spot that, yes. It was towards the end of—it was pretty close to the end of 1935 that we knew that we did not want water. Having taken that step, it led us to the indication to the road that I just spoke of, in the spring of 1936.

Q. Do you know whether the experimentation included experimentation with various different metals as catalysts? A. I know it included lots of catalysts, but you are getting a little out of my depth.

Q. Do you know whether or not it included— A. There are men here that can answer that question.

Q. Did it include a wide scope on work with different carriers for catalysts? A. Yes, I heard a good deal about various carriers, but I can not describe them.

Q. Did you come to know anything about the habit of a catalyst, as to how long it would last? Was its life an item of any consequence? A. Well, they were doing business, I know, with a silver catalyst. I was very interested every time we had a meeting, and I had a report as to how long the thing was going to last, and whether it could be rejuvenated, because it is a very considerable item of expense before you get through with it.

Q. I did not make my question very clear. Was the period of time over which a catalyst, whatever it was, would continue to act catalytically an item of importance? A. Yes; that is fundamental, I think.

Q. Some of them subside more or less quickly? A. I am sure there were such cases reported.

Q. Yes. Now, can you state, or will you please state as well as you can, when it was that you had arrived at what you considered to be a commercially operative process? A. In somewhere, I would say just after the middle, or just before the middle, I guess, of 1937, we decided that our experiments, except for enlargement, were practically over, and it was time to build a large pilot plant.

Q. My question was directed more particularly to when you had concluded in your own mind that you had arrived at a process that was commercial, not the engineering of

it, or the building. A. That was some time very late in '36.

Q. Now, by the spring of '37, had the engineering form of the apparatus taken definite form? A. As far as the pilot plant was concerned, yes.

Q. At that time did you feel that you had not only developed a process, a commercial process, but that you had developed one that involved invention? A. Yes.

Q. And did you apply for a patent on that invention? A. Mr. Carter applied for a patent.

Q. Is this the patent to which you refer, No. 2125333 (handing patent to witness)? A. The method and catalyst patent?

Q. Yes * * * [1277-1288].

* * * Mr. Watson: I will stipulate that such a patent issued to the defendant, filed so and so, dated so and so, number so and so. Beyond that I won't * * * [1292].

* * * The Court: Now, all you need to do is to give the reference to it, and the issuance date. I will limit it to that. In other words, it is a reference in the course of his chronological statement, and that is all.

Mr. Edmonds: Yes; and the reference is by stipulation to Patent No. 2125333, issued August, 1938, on an application filed May 8, 1937; and it was issued to the U. S. Industrial Alcohol Company as assignee of R. M. Carter.

The Court: Let me see if I understand it. Doesn't Mr. Adams' testimony boil down to this—I do not want to anticipate too much—I understand this would be conceded, that his company has built up a very large business in connection with this process.

Q. (Mr. Edmonds) Will you proceed to tell the rest of the story from where you are now? We will say you are at this application date, May 8, 1937, did the engineering development work continue from that time on? A. That May 8, 1937, marked the approximate date of

the completion of our experiments in, we will say, a single tube test, a single tube operation * * * [1292-1293].

* * * Q. Did you continue with the engineering developments from that time on? A. From that time on we went into a very considerable pilot plant design, construction and operation.

Q. Can you tell us approximately when that was built? A. The engineering of it was started about that time. The plant was—the engineering started on the pilot plant a little before that. The pilot plant, if I remember correctly, was in operation just before or just after the middle of the year 1937: It continued to operate, with certain ups and downs, certain measles and chickenpox and children's diseases, but with increasingly satisfactory results, so that we immediately started the engineering for a commercial unit. And by the time that we had, we will say, run the pilot plant for nine months the engineering was complete on the commercial unit, and we, in the middle of 1938, began the construction of the commercial unit.

Q. And that was completed, and the plant put in operation— A. And that was completed and put in operation in May, May 9, 1939. And it has been operating very satisfactorily ever since.

Q. Here in Baltimore? A. Here in Curtis Bay, Fairfield, just outside of Baltimore.

Q. Can you tell us what was the total cost of the development work that you went through in this research and development that you have told us about, up to the date September 25, 1936, that being the date of the application for the reissue? A. I have had those figures broken down, and that was $132,000, approximately.

Q. That is up to September 25, 1936? A. '36.

Q. Now, it has been continued from that date up to May 18, 1937. And I wish you would state that figure. A. I have those accounts to show that $19,000 more was spent before the May date.

Mr. Edmonds: That is all.

CROSS EXAMINATION.

By Mr. Watson:

Q. Early in May, 1939, this interrogatory was propounded by plaintiff to the defendant: "Since May 18, 1937, and prior to the filing of the complaint herein, has defendant, or any corporation in which defendant at the time owned and now owns a controlling stock interest, commercially practiced a process of making ethylene oxide by so subjecting a mixture containing ethylene and molecular oxygen at temperatures maintained between about 150 degrees C. and about 400 degrees C. to contact with an active surface catalyst comprising silver for direct oxidation of ethylene by molecular oxygen as to form oxidation products containing substantial amounts of ethylene oxide and not containing substantial amounts of aldehydes, and thereafter recovering ethylene oxide. (By 'commercially practiced' is meant—conducted on a commercial scale in the regular course of business and producing a product or products for the purpose of sale and sold in the original channels of trade, as distinguished from experimental or laboratory operations.)"

Now, you were advised of that interrogatory about that time? A. Yes.

Q. And it was answered, as you know, No, is that correct? A. I don't know about the date.

Mr. Edmonds: Mr. Watson, did you say that was in this suit?

Mr. Watson: Your Honor may or may not recall that a bill of complaint on the patent in suit was filed against the U. S. Industrial Alcohol Company. This interrogatory was asked in that suit. It was answered negatively. And on the basis of that negative answer the suit was discontinued. A month or two later the present bill of complaint was filed against the U. S. Industrial Chemicals Company. And that is the present suit. But this interrogatory covers the operations of the present defendant, as well as the operations of the Alcohol Company. And I want it on record that we have a sworn answer, a sworn statement on behalf of the Alcohol Company, which wholly owns the subsidiary, the defendant here, that prior

to May 3, 1939, neither of them had ever made and sold a drop of ethylene oxide or glycol produced by this process.

The Court: Well, now, in that connection I would like to ask the witness a question. I understood you to say that you did not get into commercial production until considerably after the date of this reissue patent, namely, considerably after May 18, 1937.

The Witness: My recollection is it was in May, 1939, that we got into production.

The Court: Two years later?

The Witness: Yes, sir.

The Court: Now, after this patent was issued your company presumed that you knew all about it?

The Witness: We did.

The Court: Did you have correspondence with the plaintiff company, trying to find out what each was doing?

The Witness: No.

The Court: There was no correspondence——

The Witness: No.

The Court: —in regard to possible conflicting rights.

The Witness: No. We felt sure that we did not conflict.

The Court: You went ahead?

The Witness: We obtained advice and decided it did not conflict.

May I say a word of explanation, to simplify this last matter that came up?

The Court: Yes.

The Witness: When that interrogatory came in and reached my desk, I called up the President of the Carbide Chemicals Corporation, and told him that they had asked the wrong company, and that they should ask the operating company, the U. S. Industrial Chemicals, Inc.

Q. (By Mr. Watson) Now, Mr. Adams, perhaps your memory is at fault. Didn't you tell Mr. Rafferty that the Chemicals Company at that time had not commenced commercial operations? A. Maybe I did. But I said they would commence in a few days, we expected. That is possible. But it would be the Chemicals Company that did it.

Q. Yes. A. I told him that.

Q. So that the Chemicals Company as of that date had not begun any commercial operations; isn't that right? A. There may have been a few days there. I told him we would let him know exactly as soon as the thing began operation. That is exactly what I told him.

Q. And then you did not tell them— A. I told him as soon as it began commercial operation I would let him know. You can not tell me I did not tell him, because I did, and he will admit it * * * [1294-1300].

* * * Q. Mr. Adams, you spoke of being advised by your counsel that you could freely make glycol by the chlorhydrin process. That was about 1934? A. That was at the end of 1933, but, as my testimony will show——

Q. But you were advised, as far as patent questions are concerned, that was free? A. That a process could be devised under that chlorhydrin method that would undoubtedly be free from patent infringement.

Q. You were advised in about April or May of 1936 that plaintiff here had acquired the United States patent rights to the Lefort process? A. Yes.

Q. And you also knew before you received that information that your company had been in correspondence with the French company regarding the American patent rights? A. No, not regarding the American patent rights, regarding the amount of knowledge that they had of this art.

Mr. Watson: I hand you a folder of documents which concern communications back and forth between you and Mr. Munson and Mr. Board and the French company and the Guaranty Trust Company in Paris. These

we have been given by defendant's counsel. I offer them in evidence as a group as Plaintiff's Exhibit 22. They speak for themselves.

(Photostat copies of correspondence between defendant company and its officials and French company and Guaranty Trust Company in Paris, received in evidence and marked, "Plaintiff's Exhibit 22.")

Q. You spoke of the expense involved in the use of a silver catalyst. You realize, do you not, that the silver used and the expense of the silver was not ephemeral, the silver did not run away from you? A. Yes, of course.

Q. You could always get your money back out of the silver? A. We used silver because it happened to be in this catalyst.

Q. Yes, but it was not consumed in the process? A. Oh, no.

Q. You could cash it in at any time it failed? A. But the life of the catalyst was what he was asking me about, and the interruption of the production is very expensive.

Q. You spoke of the semi-pilot or pilot plant which you said went into operation about August, 1937— A. Somewhere about the middle of 1937.

Q. 1938, I guess it was? A. No, 1938 is when we started the commercial plant.

Q. 1938 is when you started to build the commercial plant? A. That's right.

Q. Which commercial plant you started to operate in 1939? A. That's right.

Q. You have spoken of the cost of your experimental program before November, 1936. You began communications with the French company in November or December, 1935, did you not? A. No, in February, 1936.

Q. Well, you will accept whatever date is shown by the documents just offered in evidence? A. Well, it is February, 1936.

Q. And you are familiar with the fact, are you not, that up until that time, so far as the evidence in this case shows, your company or any of your subsidiaries had done no work, even on a laboratory scale, on the production of ethylene oxide or by direct combination of ethylene and molecular oxygen from air, except Mr. Carter's February, 1935, couple of tests when he ran a gas mixture over a five cent piece size of silver gauze, and in December of that year when twice he attempted to pass it over silver rivets? A. I can not answer that.

Q. Are you familiar with that? A. I am not at all.

Mr. Watson: That's all.

REDIRECT EXAMINATION.

By Mr. Edmonds:

Q. Prior to writing this letter of February 26, 1936, had you had any interest whatever in the original Lefort patent, which by that time had been issued? A. No, none whatever.

Q. Did you ever ask anybody in the Patent business to tell you anything about it? A. No, not up to that date.

Q. Prior to this letter of April 29, 1936, had you gotten a report on the patents in this field of ethylene oxide? A. I had.

Q. Did that include any note about this Lefort patent? A. It certainly did.

Q. Did it include anything definite to you about whether or not the patent was of any value to you? A. They said, under the circumstances——

Mr. Watson: That is hardly the best evidence.

The Witness: Under the circumstances that what you are aiming at, that patent is of no interest to you.

Mr. Edmonds: That's all.

The Witness: That was April 14, 1936 • • • [1304-1309].

TESTIMONY OF WALTER WILKINSON

Thereupon——

WALTER WILKINSON, a witness of lawful age, produced on behalf of the defendant, in surrebuttal, having been first duly sworn, was examined and testified as follows:

Direct Examination.

By Mr. Edmonds:

Q. You are in the employ of what company? A. The Air Reduction Company, Incorporated.

Q. And in what capacity? A. Research engineer.

Q. And have you been identified with the ethylene oxide development of the U. S. Industrial Chemical Company during the past several years? A. I have.

The Court: I do not understand what you mean.

The Witness: I am the research engineer of the Air Reduction Company, Incorporated.

Q. (By Mr. Edmonds) And what is the relation between that company and the U. S. Industrial Chemical Company? A. The Air Reduction Company, Incorporated, run a joint laboratory with the U. S. Industrial Chemical Company • • • [1015-1016].

• • • Q. (By Mr. Edmonds) You are a practical engineer, with some engineering knowledge? A. I am a graduate of Stevens Institute of Technology in 1917.

Q. You heard the testimony of Dr. Lamb? A. I have.

Q. I call your attention to the Court's question put to him on page 794, and his answer thereto, and also his answer to a closely related question on page 795, and ask you if you will state your views with respect to the matter treated in those two answers (handing transcript of testimony to witness). A. In the first question I take it Dr. Lamb was asked if the experiments which he had performed, in view of the yields which he had obtained, the conversion, would lead him to say that this was a commercial process, in view of these yields.

Q. Yes. A. In view of these yields or conversion, Dr. Lamb testified that it appeared to him to be a commercial process.

Q. That is solely in view of the conversion? A. Solely in view of that, as I take it from that question.

Q. Now, the second question has no such limitation, has it? A. In the second question I took it to be that the question referred to all points involved in the situation * * * [1016-1018].

* * * Mr. Edmonds: The second one reads, "In other words, if you were asked for such advice as I have just suggested, you would be willing, on the experiments that you have made and none other, and the study that you have made and none other, to give them an affirmative answer, Yes?" That is "Yes" as to its adaptability for profitable commercial successful operation.

Q. (By Mr. Edmonds) Now, do you agree with that statement? A. I do not.

Q. Will you state your reasons? A. There are many other things to consider in a commercial operation besides the conversion of ethylene to ethylene oxide.

The Court: Well, that is all we have been talking about.

The Witness: But there are many other things to consider besides the conversion, to make that a commercial operation. The length of life of the catalyst is one. And for short tests, over a period of a few minutes, you can not determine what the length of life of that catalyst may be. And if the length of life of the catalyst is not sufficiently long, the cost of operating that process would be too high, because you would have to do something about replacing or regenerating the catalyst. And, therefore, for that reason you can not from one experiment on one catalyst alone, with only a few analyses taken, over a period of a short time, you can not state that that would be a commercial procedure. You have not enough information to give you commercial procedure. You could not recommend, for instance, that you would spend hundreds of thousands of dollars to erect a big plant on the basis of that information

which you obtain from one small experiment, and consequently you would have to go back to the laboratory and ask the laboratory people to do more research work before an engineer could even get started on the problem. An engineer must know a good many things about a process before he can extrapolate it into a commercial proposition.

The Court: Well, what do your remarks mean? What do you mean to have inferred from your remarks, that the patent is no good, or that the patent is all right, but simply that Professor Lamb was talking too broadly? I do not see what——

The Witness: Professor Lamb was talking too broadly when he said that he could make a direct statement that from those experiments that he had performed it was a commercial process.

The Court: Let us assume that he did, where does it get us in the present case? We are concerned with whether or not the patent is valid, and more specifically with whether it gives a sufficient disclosure. And, as I understand it—maybe I do not fully understand it—I understand that what you mean to say is that you would not be quite so bold as Professor Lamb, you would want to do more. But if the patent tells you how to do more, and if you can find what we call a permanently good catalyst, then you might do the same thing that he said he would do more hastily. Isn't that about all it is?

The Witness: You might try to find a catalyst which you considered to be satisfactory for that purpose, for that procedure.

Q. (By Mr. Edmonds) Are you familiar with the developments of the U. S. Industrial Chemical Company through 1936, when this was going on? A. Yes, I am.

Q. Did the U. S. Industrial Chemical Company produce a catalyst having a pretty good rate of conversion? A. We did • • • [1018-1021].

• • • Q. What particular catalyst and support do you refer to in your last answer? A. The catalyst where the silver was deposited on pumice.

Q. Now, to go back to the first two questions asked Mr. Lamb, I ask you, if you assume that the rate of conversion that he was talking about there was the rate that would continue indefinitely unchanged, still would that be a fair basis for a recommendation that profitable commercial operations could be conducted in that way? A. In the first question of Dr. Lamb—— * * * [1022].

* * * The Court: What page are you reading from?

The Witness: I am not reading from any page.

Mr. Edmonds: The first question is 794. Your Honor's question you will see right at the end was limited to a statement based on the rate of conversion only. And I am asking him to limit himself, too, in that way to a catalyst which maintains that rate of conversion unchanged.

Q. (By Mr. Edmonds) Even so, would that experiment be a fair basis for a recommendation of the adoption of that method for profitable commercial operation? A. That is, if the pumice——

Q. Assuming that the rate of conversion lasts, without any deterioration? A. Well, we would have to consider a few other things in that.

Q. That is what I want you to mention. A. We would have to consider the fact that it is over a catalyst composed entirely of silver, which is an expensive catalyst.

Q. State what is involved in that, and how that affects this matter of profitable commercial operation. A. The cost of the catalyst is a very important thing in the total cost of the plant, provided it is a metal, like silver, which has a high value per pound. And if you were using a catalyst composed entirely of silver, and if the rates of production that you got, not merely conversion of ethylene, but the total ethylene oxide you got per pound of silver, if those things are low, then you must use large quantities of silver; and you might even use a large enough quantity to make the process uneconomical. That is why the use of supports is indicated, because by putting the silver on a support you will decrease the amount of silver and thereby decrease the total cost of the catalyst, if you can maintain the same yields and the same

total production per volume of catalyst with the catalyst on the support as you do with the catalyst using all silver.

Q. Using the catalyst referred to in that question and answer that we are talking about, would it be possible to conduct profitable commercial operations at the present day? A. I have seen nothing from the testimony of Dr. Lamb, or in his experiments which he has put in the record, which would indicate to me that you could take that particular catalyst and that particular type of equipment in which he tested it, and translate it into commercial operations, whereby you could make ethylene oxide at a profit.

Q. I think you limited that a little too closely. Take that general type of catalyst, relatively pure silver, or pure silver, whatever it was, what I am asking you is would that involve such a cost, such an investment, as to make it impossible to conduct profitable commercial operations on that basis? A. Well, if you just translate that amount of silver that Dr. Lamb used to a plant making, say, five million pounds of ethylene oxide per year, you would have, assuming that the silver had a density of about 1.3 compared to water, you would have approximately $300,000 worth of silver involved in the cost of the plant.

Q. And would that make the operation unprofitable, that amount of investment in the catalyst? A. I would say that would make it entirely unprofitable.

Mr. Edmonds: That is all [1022-1025].

CROSS EXAMINATION.

By Mr. Watson:

• • • Q. Have you ever conducted a commercial catalytic process? I am speaking of you personally? A. I have built, designed and built processes for the oxidation of such things as isopropyl alcohol into acetone, and ethyl alcohol into acetaldehyde: And these oxidations took place over a silver catalyst, with the addition of air and isopropyl alcohol or ethyl alcohol, as the case may be • • • [1026].

• • • • • • •

TESTIMONY OF ARTHUR B. LAMB

Thereupon——

DOCTOR ARTHUR B. LAMB, a witness of lawful age, produced on behalf of the plaintiff in rebuttal, having been first duly sworn according to law, was examined and testified as follows:

Direct Examination.

By Mr. Johnson:

Q. Will you tell us your age and occupation, Doctor Lamb? A. I am sixty years old. I reside in Brookline, Massachusetts, and I am professor of chemistry at Harvard University.

Q. Do you recall that in the latter part of April of this year I asked you to come down to my office in New York and, if so, will you tell us what occurred? A. I was called to your office in New York in the latter part of April, I think it was April 27th, and at that time you showed me in the presence of Mr. Watson the patent referred to as the original United States Patent of Lefort, which has been discussed in this case, and you asked me if with that document I would undertake to carry through the preparation of ethylene oxide and after examining the patent I agreed to undertake this test.

Q. Did you later do that? A. I did.

Q. Prior to making this test or speaking to me on the subject, had you read or were you informed of the contents of the Reissue patent of Lefort, which is the patent in suit? A. No, I did not see the Reissue patent prior to this conference, during it nor any time thereafter and I have never as a matter of fact read the Reissue patent.

Q. Will you tell us your education and experience which you consider qualify you to make such a test and testify thereon? A. After a considerable period spent in training and education, I took charge during the war of the Chemical Research on the defense side of chemical warfare and one of the problems that confronted us at that

time was the removal of carbon monoxide from air. It was in this occupation that I made the acquaintance of Doctor Frazer and became familiar with his great outstanding accomplishments in this connection. Other research groups were busied with this same problem and I was in charge of their operations and studies. After the Hopcalite catalyst had been perfected and its efficacy demonstrated, it was necessary to manufacture it on a considerable scale to be enclosed in cannisters that could be used in connection with masks by the soldiers and sailors in our forces to guard them against carbon monoxide poisoning. A plant was constructed and many tons or several tons of this material was manufactured under my general direction and some 30,000 such cannisters were filled for the United States Navy and were tested and shown to be efficacious as a protection against carbon monoxide.

After the war I was asked to organize and to direct the Fixed Nitrogen Research Laboratory in Washington, established by President Wilson for the purpose of, if possible, converting the immense Government plant at Muscle Shoals into effective plants for the manufacture of fixed nitrogen from the air. Our chief problem and the one to which we devoted the most time and money was the development of a catalyst for the production of ammonia from hydrogen and nitrogen. After a considerable inspection trip in Europe and after some months, more than a year of effort, such a catalyst was actually developed and has played a considerable role in the subsequent manufacture of ammonia in this country.

Subsequent to my connection with the Chemical Warfare Service and the Fixed Nitrogen Laboratory, I carried on some researches particularly with regard to the behavior of Hopcalite towards carbon monoxide and hydrogen under different conditions. This, I think, completes my active connection with catalyst research.

Q. What about your education, you haven't mentioned that? A. I studied originally at Tufts College in Massachusetts and then at Harvard University and received from both places the degrees of Doctor of Philosophy. I have studied in several universities in Germany and returned to this country to become an instructor in chemistry at Harvard University.

Q. If it won't embarrass you, will you tell us what honors you have received in the scientific world? A. Well, I have received more than I deserved. I have been elected to some honorary societies and received honorary degrees. I have been president of the American Chemical Society.

Q. In fact, you are the editor of the journal of that society, aren't you? A. I am and have been for over twenty years.

Q. And you are a member of the National Academy of Sciences? A. Yes.

Q. Did you prior to making this test on the original Lefort patent receive any suggestions or instructions from me or anyone as to how you should conduct this test? A. No, sir, with this exception, I think you or Mr. Watson did tell me to remember that I was not expected to produce this material on a large scale, that a laboratory experiment would be adequate.

Q. Will you please tell us, therefore, what you did and what results you obtained? A. May I refer to aid my memory to a report which I have recently written outlining this work briefly?

Q. Yes, perhaps you had better begin with the apparatus. Did you make a drawing of it or did you have one made? A. Yes, I made a drawing of the essential part of the apparatus, the catalyst cell, that is, a glass vessel containing the catalyst.

Q. I hand you a drawing and ask if you will identify it. Is that it? A. Yes, that is a diagram of this apparatus drawn approximately to scale.

Mr. Johnson: I offer the diagram identified by the witness as Plaintiff's Exhibit 11.

(Diagram of Doctor Lamb marked "Plaintiff's Exhibit 11.")

The Witness: The apparatus to contain the catalyst was a simple one, merely a small glass tube held in a vertical position in which the catalyst was placed and into which a thermometer was inserted, whose bulb reached into the catalyst mass. The cell was partially

submerged in a liquid bath of dibutyl phthalate, so that it could be heated to a moderate temperature when desired. In order to be sure that the gas mixture entering the cell had reached the temperature of the catalyst, we have some spiral coil glass tube through which the entering gas has to flow before it strikes the catalyst. Passing through these glass tubes warms the gas mixture sufficiently to the temperature of the liquid bath in which the cell is placed. The liquid bath is heated on the bottom by a little hot electric plate or electric heater to a convenient temperature. The apparatus for preparing the mixture of ethylene and air followed conventional lines. The ethylene was supplied from a pressure cylinder and then passed through a pressure regulator so that any excess of ethylene above the desired pressure would escape. The ethylene then passed from there through a valve and a flow meter to measure the rate of flow and then into the mixing chamber just in advance of the catalyst cell. Air was taken from a compressed air line of the laboratory, bubbled through the bottle filled with water with a trace of sulphuric acid in it. The function of the bottle I will explain later. Then, I should like to correct that—the compressed air passed first through a pressure regulator so that any excess pressure could be removed and then the air at reasonably constant pressure entered this wash bottle containing the water with a drop of two of sulphuric acid solution to which I have referred. From the wash bottle the air passes through a valve, a flow meter and into the mixing chamber referred to before. By this preliminary apparatus we were able to supply to the catalyst itself a current of air with a regulated amount of ethylene and containing small amounts of water substantially equivalent to that present in ordinary atmospheric air. In order to detect the ethylene oxide, if any, in the gases issuing from the catalyst cell, we bubbled those gases through solutions first of salt and water, to which a little hydrochloric acid had been added. In some of our experiments we also added so-called wash bottles containing some sodium hydroxide solution to collect at least a part of the CO_2, that is carbon dioxide, that might be formed in this catalyst cell. In other experiments we also collected the carbon dioxide completely by absorbing it in so-called U tubes charged with pellets of fused potassium hy-

droxide. Those were our general experimental arrangements.

Q. And did you in making this apparatus or in the tests which you subsequently conducted on it, use consciously any knowledge that was not available to the art in 1931? A. No, I didn't.

Q. Now, will you tell about the preparation of your catalyst and what you did. Perhaps this will be shortened, your Honor, if he has—he has a report which we could put in.

The Court: I think you might just let the professor go ahead and describe it.

The Witness: I first read the patent with a good deal of attention and devoted some little thought to the question of the selection of a catalyst because I felt some little professional pride in being able to pick out, if possible, a catalyst which would work the first time. At least, I did not want to make too many trys. I reasoned that the most promising single catalyst would be that comprised or consisting solely of silver because silver was so frequently mentioned in the patent and I reasoned that would be about the simplest one to prepare. I further reasoned that it was clear that a quite active catalyst was desirable because we wanted to accelerate a reaction at a low temperature and avoid a reaction which I knew took place with greater facility at high temperature.

The oxidation of the ethylene to carbon dioxide and water is one that would take place freely at high temperatures. The oxidation of the ethylene to ethylene oxide, according to the patent, took place at low temperatures, particularly around 150 to 400 degrees, and I could see that it was desirable to have the silver in as active a form as I could get it and I knew that this meant fine subdivision. I therefore decided that I would utilize some compound of silver that would decompose at a very low temperature, certainly if possible at a temperature no higher than the range specified in the patent for the use of the catalyst and I knew that silver oxide fitted those requirements, so I prepared silver oxide from silver nitrate by the regular methods of precipitating with sodium hydroxide and washing out the impurities left in the preparation as carefully as I could by repeated

washing of the silver oxide by what we speak of as decantation, pouring off the wash waters each time, in what is known as centrifuging the precipitate with a little of the wash water remaining so as to get as clean a silver oxide as possible.

We repeated this process a good many times until we were assured that the silver oxide was reasonably pure. I then had that baked in an oven to dry it at 115 degrees over night and in this way I got a cake of silver oxide about four inches in diameter, perhaps 4 inch diameter, but it was quite firm and hard. I then had that broken up carefully into granules so as not to get any more fines than possible because I did not want to waste the silver and wanted to have a granular product. This was carefully done. As a matter of fact, we only got a few fines and obtained a granular silver oxide about the size of a BB shot and free from fines.

We placed those granules of silver oxide in a glass tube, about eighty grams of them, and then proceeded to decompose that silver oxide in a furnace at a carefully controlled temperature. We plunged a thermometer right into the silver oxide and also into the surrounding furnace and raised the temperatures very slowly and then attached a device to the end of it, a glass tube, so we could tell when the decomposition of the silver oxide was progressing rapidly, and when it was complete, that is, when no more oxygen was given off, and in this way we were able to decompose all of this silver oxide with reasonable rapidity. I think it only took us a couple of hours at temperatures that never exceeded 390 degrees Centigrade.

You see, I was anxious to keep below the limiting temperature of 400 degrees given in this patent because that would be the working range of this catalyst when we got it, in this heating of silver oxide granules, these granules of silver. We were delighted to find that they were quite firm granules free from fines and we examined them under a microscope and they were very porous, at least very fine grained and were very light colored; they looked good.

We put them in our apparatus and proceeded to make the experiment in our catalyst cell. Of course, I didn't

know whether we would get any ethylene oxide or not, so I did not attempt in the first experiment to collect any of it. I simply wanted to prove its presence, so that I took some of the absorbing solution with just a few drops of acid in it and some indicator, methyl red, which would turn from red to yellow when all the acid was used up. The ethylene oxide uses up the acid and so if the acid was used up, I knew I had ethylene oxide and so you see now the reason for the wash bottle I put in at the start. I put the wash bottle in with water containing a few drops of acid so as not to have any ammonia or other alkaline ingredient which might vitiate my test and fool me and make me think I had ethylene oxide when I did not. This slightly acidulated water prevented me from making this error and I was naturally delighted after three minutes when I got a switch from the red to the yellow at a temperature of 190 degrees in the catalyst bed and at that same temperature I could see a slight differential in the reading of the two thermometers, the thermometer in the catalyst was a little hotter, two or three degrees hotter, than the thermometer in the bath outside. That was a good sign too, and then I let the temperature rise higher and higher. The differential in the temperature indicating a very rapid formation of ethylene oxide and, surely enough, additional amounts of acid added to my absorber were consumed in that first run. I added again tenth molar acid and had it all changed over, showing ethylene oxide had been formed to use up all that acid. That was the first experiment, and then we knew we had gotten ethylene oxide.

Subsequent experiments were designed to determine the amounts more accurately that were formed and I have a table here that gives a summary of the per cent. that were obtained under different conditions.

In some 11 experiments all told the period of collection in these experiments varied from 15 minutes to 30 minutes; and in the first experiment, for instance, I got 28.7 per cent. of the ethylene converted to ethylene oxide. Out of a mixture containing ten cubic centimeters of ethylene for every 510 cubic centimeters of air added.

The Court: What, in your opinion, is a good percentage of conversion?

A. Well, to tell you the truth I did not know at the time, but I have since learned that this is a good conversion.

This is a yield of ethylene oxide from ethylene. My wash bottles showed some CO_2 formed, and while I did not know exactly how much this was, I knew it was considerable, but to test this I made a final experiment where I collected all of the CO_2 formed, and in this particular experiment I got 37.7 per cent. yield or conversion of ethylene to ethylene oxide, and I got a 43.7 conversion of ethylene into carbon dioxide, or about the same volume efficiency in both of these directions.

I do not think I told you perhaps the one essential point you should know——

The Court: What about the carrier? Did you mention that?

A. I did not use any carrier. There, again, I did quite a little thinking. I realized that I had not much time, and I knew that some catalyst carriers were active in decomposing ethylene oxide, and I said, "Why assume this handicap? Why not just use straight silver? Then I don't have any worry over the catalyst carrier." • • • [755-776].

• • • Q. This table you have identified is page 4 of the report which you have in your hand? A. Yes.

Q. Will you state the efficiency of that last run where you actually measured the CO_2 carefully? A. I did not state it, but——

Q. Can you calculate it? A. I can calculate it. (Calculating on paper.)

The Witness: The efficiency defined as the per cent. of the ethylene converted to ethylene oxide based on the total ethylene consumed in passing through the catalyst, is 46 per cent. in this last experiment.

Q. And the conversion percentage is what? So that we will have them right together. A. 37.7 per cent. conversion of ethylene to ethylene oxide and 43.7 per cent. conversion of ethylene to carbon dioxide.

The volume of the catalyst used in this little cell was only 17 cubic centimeters. The temperature in this last experiment throughout the period of collection in the catalsyt bed was 230.3 degrees Centigrade.

Q. Will you define the efficiency again, what you mean by that? The amount of ethylene consumed divided into what? I believe you did not state it in your previous answer. A. I added together the percentages of the ethylene converted into ethylene oxide and into carbon dioxide, and I divided the percentage of ethylene oxide formed by the sum of these two percentages and multiplied by 100 per cent. and obtained the answer given.

Q. All right. Now, you have stated that you passed the air used through this wash bottle, not only to be sure that no ammonia or other alkaline material went into the reaction zone but also to insure that the air was approximately normal atmospheric air, as I understand you. Do you believe, from your study of the Lefort original patent that I gave you, that water is a necessary requirement in the process to produce ethylene oxide? That is, large amounts of added water? A. From my reading of the patent I had understood that water was, in general, beneficial to this production of ethylene oxide. It was given in most of the examples, and it was recommended to promote the production of ethylene oxide and I thought as long as I was anxious to get some, I had better have a little water in there, so I did not dry my air. I decided to use it either as it came or with the slight additional amount of moisture that it might pick up from going through the wash bottle, because I knew that the air that would go in from the compressor line was somewhat less humid than the original outside air before compression.

Q. But, as to further added amounts, do you think that the Lefort patent requires that? A. No, it never occurred to me that it was required to add any water to the mixture, but that it would be a pretty good thing to do it, in view of the aggregate that was said to facilitate the reaction.

Q. How long did you run this apparatus in your tests, approximately? A. Well, it took quite a long time on

each run because I wanted always, before I began my period of collection I wanted to have the conditions pretty accurately stabilized, so I would keep the current of air and ethylene gas passing through the catalyst cell and make readings of the temperature in the cell, sometimes for hours, before I got a good steady state so that I could know within a degree the average temperature of the catalyst mass during that 15 or 30 minute run. So that this catalyst, which I have told you about, was operated a good many hours and produced a lot of ethylene oxide, considering its size.

Q. And during those tests did you change the water in the wash bottle? A. No.

Q. Did you notice how much it went down, and from that will you tell us approximately how much water you put in? A. Yes, I made a rough estimate of how much water that wash bottle had lost in the 11 or 12 runs that were made, because I knew how full it was at the start, and measured down on it, and I could guess about how much had been lost. It was a Friedrichs wash bottle of the blown type with an annular spiral space just inside of the wall of the wash bottle so that the cross sectional area was not very great, and I estimated it was less than 10 centimeters of water that had disappeared in that period.

Q. In how long? A. Well, about 50 hours of total operation.

Q. And at what rate were you passing air and ethylene mixture through there? A. Well, I can't tell you exactly because I know I passed it a half a liter a minute through the catalyst, but I only used part of the gas or air from the pressure regulator for that purpose. It spilled a good deal of the air without ever sending it through the catalyst cell, so that the total volume of air that went through the wash bottle must have been on the order of a liter and a half a minute, or, perhaps, say, 900 liters an hour. That would be some 30,000 liters all told.

Q. And what percentage of moisture in air would that calculate to approximately?

* * * Moisture in the gas mixture, I should say. I believe you said a while ago 1½ liters per minute was 900 liters per hour. That is not correct, is it? A. Well, I think I better calculate it. (Calculation made by witness.) An approximate calculation shows that this would have added about .2 of one per cent. of moisture to the air that flowed through the wash bottle.

Q. Now, from this first test which you ran in this small apparatus, and having obtained ethylene oxide in the amounts you have said, what did you conclude as to the sufficiency of the disclosure of the Lefort patent to produce ethylene oxide? A. Well, I concluded, of course, that it was adequate.

Q. You also called my attention to the fact that you ran another test, on which you used a carrier; is that correct? A. Yes.

Q. Will you speak of that? A. After I had succeeded so well on this first one, I thought I would now try one with a carrier. And casting about it seemed to me that ordinary earthenware offered the best hope for an inert carrier. Of course, the advantage of a carrier was to curtail the use of silver. So we prepared granules of unglazed earthenware, breaking up the ordinary porous plates that we use in the laboratory into granules about the size of BB shot, as before, and then we impregnated these granules with a silver nitrate solution, and quite a concentrated silver nitrate solution, and evaporated and drained, and then undertook to decompose the silver nitrate thermally at low temperatures; but we found we could not decompose that material at as low temperatures as had been efficacious with the silver oxide. Well, the best we could do was a prolonged heating at about 450 degrees Centigrade, pumping out the oxides of nitrogen occasionally, and continuing the heating for a good many hours, and ultimately got out, as far as we could tell, all the oxides of nitrogen, and having nothing but metallic silver left behind. We examined the earthenware granules under the microscope, and found that we did have metallic silver partially encrusted on the grains, and not completely covering the whole grain, but the silver did not have the mat appearance. It was a shinier silver, and did not look so porous. So we were a little pessimistic about how it would work. We put it in the cell,

the catalyst cell, and repeated our tests, and found a very slight activity in this sample.

Q. Up to what temperature? A. We got no noticeable temperature rise at 190 degrees. When the temperature reached 245 degrees we did notice a little differential temperature, four or five degrees differential, and then we did begin to get a little ethylene oxide. We kept running it thirty minutes, because of the small amount. We got .9 of a per cent. formation of ethylene oxide and some carbon dioxide. We did not know just how much, but approximately all we collected in this apparatus was a quarter of a per cent. carbon dioxide. So our actual tests confirmed our pessimism; and we decided that it was necessary to make another experiment, that we would have to decompose that silver nitrate at a lower temperature, probably by careful reduction in hydrogen. But we did not do that at that time.

Q. What was the temperature limit of the bath which you were using? Could you have carried that to much higher temperatures than that? A. Well, somewhat. We used dibutyl phthalate for the bath, and at 250 degrees it began to smoke a good deal, and decompose, so it would not be feasible in this bath to go to a much higher temperature, and we would have had to alter our experimental arrangements.

Q. Did the results which you obtained on this second test affect your opinion previously expressed as to the sufficiency of the disclosure of the original Lefort patent? A. No, it did not change my opinion.

Mr. Johnson: I offer the written report which the witness has identified as Plaintiff's Exhibit 12.

(Report of Professor Lamb marked "Plaintiff's Exhibit No. 12.")

Q. (By Mr. Johnson) You also made a curve, which I have on graph paper. What does that show (handing paper to witness)? A. Well, this gives in graphic form the percentages of ethylene oxide obtained in our several experiments. I had expected to make a better job of this, from the draftsman's point of view, but I just did not have time. But it shows that as the temperature rises, from the lowest temperature we worked at, 215 de-

grees, up to the highest temperature of 245 degrees, there is a gradual rise in the amount of ethylene oxide produced. The curve seemed, however, to be approaching a maximum. I don't know how much higher it would rise.

Mr. Johnson: I offer the graph which the witness has identified as Plaintiff's Exhibit 13.

(Graph prepared by Professor Lamb marked "Plaintiff's Exhibit No. 13.")

The Court: I have one or two questions, Prof. Lamb, that I would like to ask.

You said that you did not consider that water was mandatory, that is, the addition of water was mandatory in the patent. In that connection, I would like to ask you how you reconcile that conclusion with the fact that all of the claims, that is 1 to 7, inclusive, speak of a process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, or of oxygen and steam. Do you reconcile it by the fact that you think that may be taken as referring to the water that is present anyway in the atmosphere, in the air used?

The Witness: Well, I thought that, too. And then I thought, also, that the patentee had claimed what he thought was his best embodiment of the invention, which was having the water in it. There seems to be no doubt in the specification that water was beneficial. I think he claimed just that. I did not really study the legal aspects of it at all. But——

The Court: No, I did not intend to ask you from the legal aspect. Then, it would necessarily follow, I assume, from your conclusion, that even though, as I understood you to say, you have not up to the present time read the reissue patent, it would follow from what you have said that even if you studied it, and even if it be assumed that water as a requirement, we will say, is left out of that, you think that is not any material departure, not in any legal sense, but in a practical chemical sense.

The Witness: Yes, that is true, your Honor. As a matter of fact, when we first constructed the apparatus, an hour before we started our run we did not have any

wash bottle in there. It was not until I thought, that it occurred to me, just as we were going to start the experiment, that, "See here, how do I know there is not a little ammonia in my air that I am drawing in from the compressor system," because that ammonia would go right through and neutralize some of my acid, and make me think I had ethylene oxide when I really did not have it. That was really why we put it in. And I and my assistant talked it over and said, "Well, it won't do any harm, and the patent says it will help, let us put it in." We need to have something to take out the ammonia; and the air is moist anyway.

Q. (By Mr. Johnson) I neglected to ask you, Dr. Lamb, this question. You frequently used the word "we" and now you refer to an assistant. Who was he, and tell us whether he had any previous knowledge of the reissue, or of the patent, or what was to be done?

The Witness: I had a very satisfactory assistant named Mr. Damon, Mr. Edwin Damon, who is an excellent analyst and operator, but who had never had any experience with catalytic studies, nor indeed with methods of testing catalysts, but he was an excellent analyst. He, for instance, had never seen or used a flow meter before. He constructed them and calibrated them with the utmost care and skill. He was an excellent analyst, and actually performed the analyses that I referred to, although I verified substantially every end point that he took, and the weighings that he made.

Q. Well, did he know anything about this situation before? A. No, he knew nothing except what I told him about the problem that had been presented to me.

The Court: Now, I have one other question. I realize this may be anticipatory, but if we go ahead with the testimony and at the same time get at the point of law, so much the better. If I understand you, Prof. Lamb, it would follow as a necessary result of your statements that you do not think there is any real materiality in what is stated in the French patent, No. 771,650, by the French Societe, to the effect that an improvement had been found. It is expressed in this language——

Mr. Johnson: I believe the witness, your Honor, has never read that patent.

The Court: I am assuming he has never read it.

The Witness: No.

The Court: But you heard the testimony about it?

The Witness: I heard some testimony.

The Court: The statement is made, the applicant has improved this process—well, I might read back a little: "The present invention relates to the preparation of ethylene oxide by the direct oxidation of ethylene in contact with pure oxygen or air, and the reaction or direct oxidation requires special precautions against explosion hazards. In connection with the industrial oxidation of ethylene it was suggested as early as 1904 that water vapor be introduced into the reaction. The explosion hazards are thus caused to disappear. But the oxidation products have always been aldehydes. The applicant has improved this process by bringing into play catalysts suitable for obtaining a specific reaction which gives ethylene oxide as the oxidation product. The thus improved process marks a considerable step forward in the technique of the production of ethylene oxide by the direct oxidation of ethylene. But the necessity of vaporizing large amounts of water requires an expenditure of calories, which obviously contributes its share to the production cost of the ethylene oxide obtained."

Now, I understand in that latter sentence he is talking about the patent that you used. "The present invention"—he is talking now about his alleged improvement—"remedies this drawback. It has as its object a process for preparing ethylene oxide by the direct oxidation of ethylene without water vapor and with no explosion hazards. This process is characterized principally in that the ethylene-oxygen or ethylene-air mixture is diluted with a large amount of an inert gas."

Now, if I understand you correctly, you say that those are, for all practical purposes, from your scientific viewpoint, those are merely alternate things, and that both are equally suggested by the original patent.

The Witness: Well, the answer, I think, is "Yes." Certainly, as far as my general knowledge is concerned, and my own experiments are concerned, the cost of vaporizing the water in that wash bottle of mine was certainly negligible—it did not cost anything—and there was moisture in the air supplied gratis, and it cost nothing. I can not see the novel contribution. Of course, it is known that with an exothermic reaction you can not have too high a concentration of your combustible materials, and you must provide for the dissipation of the heat; and a great variety of diluents could have been used, involving no exercise of invention, I should think.

The Court: Then, you disagree with the emphasis that Professor Taylor and Professor Reyerson put on this use of water?

The Witness: Certainly, I do, as far as anything I know.

The Court: Go ahead, now.

CROSS EXAMINATION.

By Mr. Barrows:

Q. What was the sort of compressed air you used? A. Laboratory compressed air. The compressor is not actually in our laboratory, but it is in an outside university building, and it is piped through the ground to our laboratory, and comes to a fairly good-sized storage tank, with a pressure regulator in our sub-basement, and is then piped from our storage tank to various parts of the laboratory.

Q. What pressure is that air held at? A. The air in the lines, the distributing lines, about 4 pounds above atmosphere.

Q. And is that the highest pressure that it is compressed to in the compressor compressing it? A. Well, I can not tell you about the pressure in the University compressor line, but I do not think it is a very high pressure line.

Q. Well, would that pressure remove part of the normal moisture content of the air and reduce it somewhat? A. Well, it would depend somewhat on the prevailing

humidity. But if the air were 100 per cent. humid that entered it, it would precipitate moisture.

Q. Now, you said you were asked on April 27th, as I recall it, to carry out the experiments; is that correct? A. That is correct.

Q. And the first experiment recorded in your report is May 26th. Is that the first experiment you did? A. Yes, it is.

Q. It was about a month after you were asked to do it before you carried out the experiment? A. Yes, that is right, before we made the run to test the catalyst.

Q. How long a time was required in making the catalyst? A. It wasn't very long (referring to records), two or three days is my recollection. We heated the material overnight at one stage of the operation and then it is also true that after we got our silver oxide we made a number of small scale heating experiments to see how it behaved at different temperatures. We found that, placed in a little glass tube and stuck right into the flame, it heated up and almost exploded, so sudden was the decomposition.

Q. With the air? A. Yes. And then we heated some more gradually, and so on, and tested it with a little hydrogen and found it difficult to control.

Q. Hydrogen and air? A. No, first we tried out straight hydrogen. Of course, that was very difficult, and heated slightly the temperature rose with great rapidity.

At that time I had read pretty carefully an article by Professor Lewis, who was my old teacher, on decomposition of silver oxide, and I then proceeded to decompose it pretty much according to his directions. He gave the temperatures needed for rapid decomposition of silver oxide, and from that point on the preparations were pretty rapid so that I should say it took us perhaps three days all told in making this catalyst.

Q. Where was that article published, or book published, you referred to? A. Well, I think it was published in two places, but my particular copy was the article that he published in the proceedings of the American Academy.

Q. What date, do you know? A. It was about 1905 or six.

Q. These preliminary tests of taking silver oxide and heating it under various conditions were all made before you finally made the catalyst, is that correct? A. Yes, that preceded it by perhaps a day before we fixed on our heating schedule.

Q. Then this experiment on page 5 of silver on the carrier dated June 3, 1940, was in between the dates of the June 1 and June 9 experiments recorded on page 4?

The Court: What has all this got to do with our little problem? What is the necessity of taking all of these dates and so forth?

Mr. Barrows: . . .

I want to ask him if this record of June 3 was reported to the attorneys for the plaintiff before he carried on his experiment of last Sunday, June 9, just three or four days ago.

A. (After referring to records) Yes, I think I told the attorneys about this experiment when I came down here last week.

Q. Were you asked to make another experiment last Sunday? A. No, I was not asked. As a matter of fact, it is a little matter of professional pride. I felt that we ought to have collected the CO_2; I knew how to do it, and I had hesitated to take the trouble, we really were terribly busy at this particular time, I had a thousand other things to do besides these experiments at this time of the year, and I just had time to get those U tubes fixed up and tested and carry through them a quantitative collection of CO_2.

Q. You have had a great deal of experience in carrying out catalytic experiments, have you not? A. Yes, in the old days I had a good deal of experience.

Q. And you have had a good deal of experience as an expert in patent litigation? A. (After a pause) I can not — I suppose it is dull of me, but I can not seem to remember testifying in a patent case on catalysts before. I suppose not.

Q. But you have had a good deal of experience in various connections with catalytic work? A. Oh, yes, indeed.

Q. And you are a member of the Committee on Catalysts and have been for a number of years? A. I don't think so recently, but I was originally on that committee.

Q. And you have made it your business to keep track of the development of the literature on catalysts? A. I can not say I do. I am sorry, but I do not.

Q. In former years that was your custom? A. It was during the period up until 1925 or 1926; I was very much interested then in that field and I had time to do it, and I did keep pretty good track of catalytic work at that time.

Q. Of course, this work which you did and which you recorded was done at the request and at the expense of the plaintiff here? A. Yes.

Mr. Barrows: That is all.

REDIRECT EXAMINATION.

By Mr. Johnson:

Q. You said that you made this apparatus or this assistant of yours made it? A. Yes, Mr. Damon actually built a good deal of this, and some of the more difficult features, the flow meters, were manufactured by the glass blower in our own glass blowing shop.

Q. And then those were calibrated? A. Yes, it took weeks to get that analytical apparatus effected.

Q. Does that account for the time lapse between April 27, when we asked you— A. Yes, the first three weeks were spent almost exclusively in getting ready the analytical apparatus and in familiarizing ourselves somewhat with ethylene oxide, because I did not know much about ethylene oxide, I had never worked with it before, so we got a cylinder of it and fussed around with it and became fairly familiar with it.

Mr. Johnson: That's all.

The Court: If you did nothing more, if you stopped right here and did nothing more in the way of experimentation or laboratory work, and you were asked by some third party industrially concerned with the thing,

whether from what you had done, under the teachings of this patent, you were satisfied that that company could produce with commercial success, that is, profitably from the point of view of conversion, ethylene oxide, you would answer that, yes? A. Yes. That is a surprising thing, too, your Honor, because when I first saw this patent I was more or less dumbfounded, to tell you the truth, to think that you could realize this reaction, which, to a chemist, is quite a surprising reaction, and I did not know that it had been achieved.

The Court: Do you mean that you sympathize with a Court that has to sit through it?

The Witness: Yes, I do. I should certainly tell anybody that asked me that it looked to me, from my limited experience, it looked easy.

The Court: You mean now you would tell them?

A. I would have told them before I came into this court. I mean, after these experiments had been performed.

The Court: In other words, if you were asked for such advice as I have just suggested, you would be willing, on the experiments that you have made and none other, and the study that you have made and none other, to give them an affirmative answer, yes?

A. Absolutely.

The Court: That's all * * * [770-795].

* * * * * * * * *

Thereupon——

DR. ARTHUR B. LAMB, resumed the stand and testified further as follows:

Direct Examination.

By the Court:

Q. My main question relates to this: Have you, since you testified, had a chance to study the reissue patent? A. Last evening I read it for the first time, so I have some familiarity with it.

Q. Well, then, do you feel you are in a position to testify more fully now from a scientific standpoint as to whether you find any material difference on this question that has been dwelt upon so much, the alleged departure, in that water is required in the first patent and not in the second, as an addition? A. I certainly have not heard anything that has changed my ideas about water as an ingredient in this reaction. I was a little disturbed at Professor Taylor's failure to give all of my reasons for putting the water in. In my experiments I needed to have an indicator for ammonia; and I discussed whether or not to put the water bottle in, that would add additional water. And, as I have stated in my testimony, I thought that after all water is recognized in this patent as advantageous, and it would certainly do no harm if you put it in. It might even get me larger yields of ethylene oxide. So there were really two reasons why it went in, although the use of it as an indicator was the primary one. But I certainly was astonished when Professor Taylor said that I, who have some familiarity at least with catalysis, and had endeavored through my best efforts to follow the first patent, had inadvertently apparently been doing the second patent. It does not seem to me that they can differ very greatly if a person skilled in the art practices the second one when he thinks he is practicing the first.

Q. Well, now, that leads to the other question I was going to ask you. You practiced the first, and have given us the benefit of the results of that practice? A. Yes.

Q. Now, you have since read the reissue? A. That is true.

Q. And you had not up to that time read the reissue? A. That is true.

Q. And you state since you have studied it? A. I have studied it.

Q. Well, now, suppose in the light of everything you know on both patents to date, that is, the experiment you made under the first, and your study of the second in the light of the first, suppose you were now given this second, or reissue, patent, and asked to return to your laboratory and follow out the teachings of the second, would you or would you not feel you were required to make any de-

parture from what you previously did under the first patent, and if so, in what respects? A. I do not think I would have done a bit differently.

Q. I am referring now to claims 8 and 9, because the other claims are identical. A. Yes, Claims 8 and 9 mention the carrying on of the reaction in the presence of water. And I think I would have done just the same, only it would have been a little easier for me, because I would not have had quite so much hesitation in regard to the selection of the catalyst. The number of optional catalysts is somewhat reduced in the reissue patent. It would have been a little easier for me. But I think I would have done the same experiment.

Of course, this matter of water, too, I think is a little hard to see in its correct light, on account of the numbers that are involved. We speak of 1½ per cent. of water as very little water. Well, it is, compared to the total bulk of air, or the total amount of ethylene that went in, or the total amount of materials that flow through the system. But compared to the amount of ethylene that you are using, particularly compared to the amount of ethylene oxide you get, your water content is large. The amount of water that you get in the effluent gases, under the conditions I worked, and they were pretty nearly comparable to industrial conditions, was greater than the ethylene oxide then produced. In other words, although the percentages are small, the relative number, the relative amount of water vapor in these reacting gases is very large, even as I carried it out * * * [1174-1178].

* * * Cross Examination.

By Mr. Barrows:

Q. Dr. Lamb, I believe you said you found it easier to read and follow the reissue than the original. Just what did you mean by that? A. Well, may I have a copy of the reissue patent?

(Handed to the witness.)

The Witness (continuing): In the first patent there is a long and very numerous list of catalyzers that may be

used—I think there has been discussion about that in the testimony—while in the reissue the statement is relatively brief about the catalysts that may be used.

"The surface catalyst is preferably silver, as stated, but other metals, such as bismuth and antimony may be used. Likewise, oxides of these metals may be used. Experiments have also indicated that the catalyst may be silver activated by the addition of small amounts of gold or copper or iron."

I do not seem to see anything else in the specification about the chemical nature of the catalyst.

Mr. Watson: I call your attention to line 47.

The Witness: Well, I do not see any additional catalysts mentioned there, except that it speaks of silver in finely divided form.

Q. (By Mr. Barrows) Silver in finely divided form imports such a catalyst as you prepared from the oxide, by reduction? A. Yes.

Q. Now, you find no mention of silver in finely divided form in the original patent, do you, except in the reference to a silver colloid in the modus operandi 3, and reference to silver in powdered form in modus operandi 2? A. No, I think there is no other mention in the specifications * * * [1179-1180].

* * * But, of course, I could point out that I did not need much instruction on the importance of using silver in a finely divided form.

Q. Well, if you had followed Example 3 of the original patent you would have used silver in the particular form of a silver colloid, would you not? A. Yes.

Q. And the catalysts that you prepared and used would not have been suitable for use in Example 3 at all? A. I don't know about that, Mr. Barrows.

Q. At least the catalyst you used was not a silver colloid? A. It was not in suspension.

Q. Can you say whether or not it was or not a silver colloid? A. I can't say categorically because of the fact I don't know the number or the size of these silver par-

ticles that were the constituent particles of my silver pellets.

Q. But you do find in modus operandi 2 reference to silver in powdered form? A. Yes.

Q. And also in the form of wire gauze? A. Yes.

Q. And in the example you also find the use of a mixture of ethylene, air, water vapor and hydrogen, do you not? A. Yes.

Q. And you made no attempt to carry out the process of that example at all, did you? A. I did not, in so far as the inclusion of any hydrogen was concerned. I did not add any hydrogen to the mixture. As I remember it, hydrogen was spoken of as a particularly optional addition in some place in the patent.

Mr. Fairbank: Line 4?

The Witness: Line 5, it is * * * [1181-1182].

* * * * * * *

TESTIMONY OF GEORGE H. LAW

Thereupon——

DR. GEORGE H. LAW, a witness of lawful age, produced on behalf of the plaintiff in rebuttal, having been first duly sworn, was examined and testified as follows:

Direct Examination.

By Mr. Johnson:

Q. Will you state your name, age, residence and occupation? A. My name is George H. Law; age, 35; I reside at South Charleston, West Virginia; chemist is my profession.

Q. And you work for the plaintiff company, is that correct? A. Yes.

Q. How long have you been with the company? A. Approximately eleven years.

Q. And you, in the early part of 1936, carried out some tests on the original Lefort patent? A. Yes, I did.

Q. What were your qualifications at that time? A. You mean my scholastic qualifications?

Mr. Johnson: Yes.

A. I graduated from Lehigh University in 1929 with the degree—excuse me, in 1926, with a degree of chemical engineer; from Yale University in 1929 with a Ph.D. degree, majoring in organic chemistry. I believe that approximately half of my time while I have been employed by Carbide and Carbon Chemicals Corporation has been devoted to working on vapor phase contact catalysts • • • [796-797].

• • • The Court: I think for the present anyway I would like to limit this witness' testimony to answer to such questions as follows:

Q. Did you follow the teaching of this original U. S. Patent in making the certain experiments for your company? A. Yes, sir.

Q. When did you do that? A. February, 1936.

Q. Why were you asked to do it? A. I am not quite sure.

Q. You weren't given any reason except to go ahead and do it. A. By my immediate superior.

Q. How many experiments did you make? A. Over a period of time?

Q. In all, that have been submitted here.

Mr. Watson: That is up to the time we got the rights.

Mr. Johnson: Prior to the time you purchased the patent.

The Witness: I am not quite certain when we purchased the patent.

The Court: You made numerous ones.

The Witness: I would say that book contains about twenty experiments.

By the Court:

Q. And you have heard the testimony of all the other experts here? A. Yes.

Q. And you have heard the testimony of the two experts for the other side, who testified with respect to the apparatus they used, and their claims that they made ethylene oxide successfully? A. Yes.

Q. You heard that? A. Yes.

Q. Did you follow substantially the same methods in taking the teachings of the patent? A. I think my methods were essentially those of Doctor Lamb, except that we extended that work to supports.

Q. You did what? A. We extended that work to include supports, catalyst carriers.

Q. What results did you achieve? I mean generally speaking, out of a number of experiments that you performed, what was the conversion percentage of ethylene oxide that you got? A. After about four, or possibly five weeks work here on rather crude laboratory apparatus, I believe our maximum yield was about ten per cent. and our efficiency about fifty per cent. We were using at that time a silver catalyst as I recall, at least part of the time a silver catalyst which was supported on the filtros that has been discussed.

Q. Do you claim that was satisfactory or not from an industrial point of view? A. Well, it would be rather hard to say. As I said before, we were operating on a laboratory scale and on relatively crude apparatus and that indicated to us, I think all the members of our company, that there would be no question at all but we could go ahead from there and operate an industrial process.

Q. Were all of these experiments you referred to borne out—I mean represented by the figures that have been put in evidence? A. That figure I gave you we obtained toward the end of these experiments. In the first two experiments we did not obtain any quantitative data and as we progressed we got more and more quantitative data and toward the end of this series of experiments we actually got quantitative data that had the values I have told you.

Q. What did you say to your company? Did you have to make a report to your company? A. No, sir, as soon

as we got the first qualitative test, Doctor Curme came down the next week, he is our vice president in charge of research, came down the next week and insisted that we actually isolate some of the material. You understand, the original tests were obtained by chemical methods, not by isolation, and I gathered he was very skeptical whether we actually made any and he came down and we demonstrated that we could isolate some ethylene oxide and I think immediately following that, even before we had those figures I reported to you, he was satisfied we could go ahead from there. That is my impression.

Q. And that ended your work? A. Oh, no, sir, I went ahead then, we had a great deal of engineering experimental work.

Q. I mean it ended your work on these experiments, did it? A. We went ahead then and did large scale work. There are a great many things to explore in engineering work and we went ahead from there largely, I would say, on development work.

Q. What do your notebooks cover? That is one thing I want to get, that are here in evidence?

Mr. Johnson: They are not in evidence, your Honor. I inadvertently misled you. They were given to defendant's counsel in connection with the deposition of Doctor Curme which took place prior to trial and it is not in evidence.

By the Court:

Q. What do your notebooks cover? A. That notebook covers a period I think of approximately five weeks or longer.

Mr. Johnson: February 11th, 1936 to March 6th, 1936.

The Court: Were you actually producing ethylene oxide during that period? A. On a very small scale on the apparatus we then had.

Q. You admit it was on a smaller scale than you later produced and on a smaller scale than Doctor Lamb produced? A. No, I think if anything a little larger than

Professor Lamb, in that same order of magnitude. I believe we started on a somewhat larger scale and possibly five or six months later developed——.

Q. I mean when I said on a large scale, I am speaking of terms of conversion or efficiency? A. Excuse me. Yes, it was smaller than Doctor Lamb.

Q. You did not get as good results in any of the experiments covered by that notebook as he stated on the stand he got? A. No, sir, we didn't.

Mr. Johnson: We offer this notebook in evidence.

Mr. Edmonds: Is that to be received in evidence? If so, we will have to go into these tests in some little detail.

The Court: Why do you have to go into these tests? I don't want to hear them. Here is a witness who admits, as I understand it, that up to the time covered by this book, by this process he wasn't drawing ethylene oxide off in satisfactory quantities but that he did it later. Isn't that in effect what you said?

The Witness: By satisfactory——

The Court: What you call commercial purposes, you were not satisfied that you were getting enough conversion?

The Witness: We were not as satisfied with what we got then as with what we did get later.

(First notebook of witness Law marked "Plaintiff's Exhibit 14.")

By the Court:

Q. And later on you say you did find out and produced an efficiency of conversion, increased it, I mean? A. Yes.

The Court: What on earth is the sense in going through all the figures? After you have done it, the witness admits the very thing that presumably you want him to admit.

Mr. Edmonds: If he will admit further that the first half a dozen efforts were fruitless, that is ended there.

By the Court:

Q. Were they fruitless or not? A. We did not obtain any ethylene oxide in the first series of tests referred to, requiring about twenty-four hours of actual operation.

Q. They were in effect failures? A. We did not get any ethylene oxide.

Mr. Barrows: And in those tests you used silver gauze catalyst.

Mr. Johnson: Your Honor will permit me to ask the same question Mr. Barrows wanted to ask because that is what I want explained in the record.

The Court: Very well.

By Mr. Johnson:

Q. Why did you use this silver gauze when you first began your work? A. We wanted first of all, if I recall, to employ silver without anything else to give us a convenient thing to use to insure the formation of a form of pure silver. We used it knowing that it is a massive smooth form of silver which would ordinarily not be considered to have catalytic activity, and we also knew at that time that metals of that type, smooth sometimes, acquired a catalytic surface in operation. It was known that is the case in the platinum gauze used in ammonia oxidation and also occurs in silver gauze used for the oxidation of hydrogen, as I recall. We selected it and ran it knowing those things. As I say, the first test with the gauzes lasted about fifteen hours and we thought perhaps it had been contaminated and put another in and ran that about eight hours.

Q. Was that method enough to develop the surface you are speaking of? A. No, our gas analyses indicated that it had no catalytic activity in the range over which we wished to operate; that is, below 400 degrees, and that apparently this surface had not as yet developed. We were getting no oxidation of ethylene to speak of below 400 degrees.

Q. May I ask the witness one more question? What he did to develop that surface on the silver gauze? A. We dipped the silver gauze in molten silver nitrate again

with the idea of using silver alone and decomposed it by heating it thermally, as I recall, about 600 degrees, and we did get ethylene oxide with that catalyst.

Q. This further work you speak of after you acquired the patent, was that engineering or research work like the previous? A. Primarily it was engineering work. In the course of that we were able to develop some improvements which I would consider more in the light of research work. I don't mean to say the process would not work without these things because it will, but we were able to develop some improvements. Primarily what we did was engineering * * * [802-812].

* * * * * *

TESTIMONY OF EMORY P. BOYNTON

* * * The Court: How many more witnesses have you?

Mr. Watson: I think I have to call Mr. Boynton, who was called and put at the disposal of Mr. Edmonds this morning.

The Court: What do you want to ask him now?

Mr. Watson: I wish to ask him if he had in front of him when he prepared the application for the Reissue patent in suit the late French or British patents of the Societe. It has been intimated by the defense that the Reissue was prepared with the knowledge of those late French ones and with the deliberate motive of reaching out to grasp something not in the original.

The Court: I thought that was asked him or certainly impliedly asked him this morning. That was implied in his answer when he said that he did not know of anything, that he was speaking directly in connection with an application akin to the British application, wasn't it?

Mr. Watson: He was saying that he made a diligent search of all the United States applications ever filed by this French company at the time the plaintiff bought and that he found no record.

The Court: Yes, of an American application.

Mr. Watson: Yes, of an American application.

The Court: And now you want to ask whether he had the third French patent before him when he did what?

Mr. Watson: When he prepared the application of the Reissue of the original.

Thereupon——

EMORY P. BOYNTON, a witness of lawful age, produced on behalf of the plaintiff in rebuttal, having been first duly sworn, was examined and testified as follows:

By the Court:

Q. Do you understand the question? A. Sure.

Q. What is your answer? A. Your Honor, I had nothing before me except the original patent. I had not heard at that time of British specification 431 something or other and the French patent 771,650, I believe it is.

Direct Examination.

By Mr. Watson:

Q. Do you know whether you had those before you at the time you obtained an allowance of the Reissue? A. No, sir, I did not see either of those documents or any copies of them or never heard of them until after the Reissue patent had been issued.

By the Court:

Q. Well, in a few words, what were you motivated by primarily, what were you acting on? A. On the strength of my investigation of the original patent I had decided that it was a very fit and proper case for the application of the Reissue law. It seemed to me that here was a man who had, through what I would call gross ineptitude of a patent solicitor, been given claims of extremely narrow scope for an invention which is a basic invention if I ever saw one and to me it seemed that was a miscarriage of justice that in all equity should be remedied and that is exactly what our Reissue statute is for. Having decided that and having before me the original patent, of course, I had at least six out of the seven French disclosures, that is the 729 something or other patent.

and its additions and the 739 French patent, and I think its addition, I had at least six of those before me, which were the documents referred to in the oath of the original patent. I believe one of them was missing at the time I drew the application for the Reissue but I had at least six of them and having looked at six and the original patent I then wrote the first of the Reissue specifications and that was not written in September, '36 as has been said here. It was filed then but it was written sometime earlier in that summer and forwarded to France to be executed by the inventor, Mr. Lefort, but he was on his holidays and was then, I believe, no longer connected with the French company and it was not until late, not late, but early in September, about the middle, perhaps, the 10th, I think that he was located and brought to Paris where he signed the Reissue application and then it came back and it was filed in September.

Q. You mean the events or the series of events that more directly than anything else led you to prepare the application was the series of events covered by the original Lefort patent, is that it? A. That is right, but excluding this one that has been called the third French patent.

Q. You mean that was the main thing that started you off? A. Yes, I studied these patents and the original patent and its history in the Patent office and from that I concluded that Reissue should be possible and that this was a very proper case for the Reissue statute.

Q. Under whose direction were you doing that? Or was that your idea? A. I am employed by the plaintiff corporation as a patent attorney.

Q. What first started you off on it? A. I don't recall just when I first heard of this Lefort patent but at about the time of these negotiations, at the time they were being conducted by cable between our New York office and our representatives in France to acquire rights under the patents, I was asked to say whether or not that patent would cover the process disclosed in it and I found a wealth of disclosure and great poverty of claim, which on investigating the facts in the file history and in these French patents struck me as being entirely inequitable.

Q. Let's see, I am a little confused. Are you talking as of what time? There is a period here when they were believed not to be any good, the French patents, by that company? A. Oh, no, this was after Doctor Law had gotten positive results.

Q. This was all after he had gotten positive results? A. Yes, that is correct. I am speaking of the time probably in May, I believe, April or May of 1936, which was after Doctor Law had gotten his results and Doctor Curme and his associates had completed their negotiations to acquire rights under the patent.

Q. That is under the American patent? A. Yes, under the American patent. We have no rights under any other patent.

By Mr. Watson:

Q. Mr. Boynton, a photostatic copy of the assignment of the patent in suit has been offered in evidence by the defendant. Is that the common form of assignment in use by your company, do you know? A. Well, it was not a printed form, you know, Mr. Watson. The assignment was drafted specially for this instance to cover the assignment to us of the original United States Patent and the only United States application that we have ever heard about and in it we put the usual provisions that we always put in all of our assignments for divisions, or extensions and continuations and reissues. At the time that assignment was drawn I had already recommended and had started the work of preparing the Reissue application, so I imagine I considered these questions with more than usual attention, but we put the matter in all of our assignments, those that are used within our own company for transferring patents or applications from individuals to the company, from one unit of a corporation to another unit and from outsiders and in every case we provide for the Reissue rights to be included and the signing of the oaths and that kind of thing. As a matter of fact, this is standard among all corporations and I happen to know it is a usual practice of the defendant in this suit.

Q. How do you know that? A. Because at one time or another I acquired a certified copy of an assignment

of a patent that has been discussed here, the Carter patent, 2,125,333, and it is a printed form used apparently, rather generally. This is an assignment from Ray M. Carter to the Air Reduction Company, Incorporated, and on a printed form with respect to Reissues and that sort of thing that was put in the assignment from the French company to the Carbide and Carbon Chemicals Corporation of the original U. S. Lefort Patent * * * [898-905].

* * * DIRECT EXAMINATION (continued).

By Mr. Watson:

Q. Mr. Boynton, have you made inquiries from the United States Weather Bureau in Baltimore with respect to the humidity in the air over a year's period? A. Yes, sir, I obtained from the Weather Bureau, the Customs House here in Baltimore, a printed form 1030, which contains data on the relative humidity in temperatures and other meteorological data for a period of the past approximately thirteen months. I had that calculated by one of the engineers of our company, to show the per cent. by volume in the air for the various days, of water vapor.

Q. Is that the tabulation on the sheet which I hand you (handing paper to witness)? A. Yes, this is the tabulation.

Mr. Watson: I offer that tabulation sheet of the Baltimore weather conditions on water vapor in the air, as Plaintiff's Exhibit 19.

(Tabulations of Baltimore weather conditions on water vapor in the air marked "Plaintiff's Exhibit No. 19.")

Mr. Watson: That is all.

CROSS EXAMINATION.

By Mr. Barrows:

Q. Mr. Boynton, when were you admitted to the Bar? A. I don't remember the month. It was either October or November, 1933.

Q. And in 1935 and '36 you were employed by the Carbide & Carbon Chemicals Corporation, in the Patent Department. A. That is correct.

Q. Who first called your attention to this original Lefort Patent? A. I believe that it was Dr. Perkins of our South Charleston Laboratories, who asked me to get some copies of it for him.

Q. And who asked you to investigate this patent? A. One of my superiors. I don't recall whether it was Mr. Scheffler, who is the head of our Patent Department or Dr. Curme.

Q. And you did make an investigation and report on this original Lefort Patent? A. Yes, I made an investigation.

Q. And you knew at that time what the process of the plaintiff was, as developed up to that time? A. No, I cannot say that I did. I probably knew that they were working on the direct oxidation of ethylene to ethylene oxide with the silver catalyst, but I had no idea of the procedural details.

Q. So your report was not then an infringement report at that time? A. Well, it was a rather comprehensive report on the subject of the patent, as respects its possible merit and scope.

Q. Showing that the patent as it was developed was limited to the use of water. A. I don't recall that I drew any such conclusion, Mr. Barrows, although having seen the claim so frequently lately I would say that water or steam was included in all of the seven claims of the original patent.

Q. Now, then, the idea of reissuing this patent was your idea, I take it? A. Well, in my report I pointed out the facts that I spoke of yesterday, to the effect that the invention seemed to be far broader than the claims, and the file history showed that the patent attorney who had prosecuted it in this country had done a very poor job of getting claims even partly commensurate with the scope of the invention, so I said that it seemed to me to be a case where reissue should be possible, to improve the protection for the invention that was disclosed.

Q. And you were the one that prepared the reissue application? A. That is correct.

Q. And the reissue oath? A. Well, I undoubtedly had assistance in preparing both of those things, but I prepared them, yes.

Q. You prepared the assignment of this original patent from the French company to the plaintiff? A. No, I formulated what should go into the assignment, but the actual assignment was drafted by another attorney for the Corporation.

Q. Do you recall that in that assignment there was a pending application included as well as the issued Lefort Patent? A. That is correct.

Q. And did you take over the prosecution of the application as well as the handling of the Reissue? A. That is correct. Some time, I believe in November of 1936, I finally got the file from the United States Attorney who had previously handled it, of that Francon application that is named in the assignment, together with the original patent.

Q. Did you prepare or aid in preparing the Curme affidavit that was filed with the Reissue application? A. Yes. As a matter of fact, I attended to the actual typing and the legal portions at the beginning and end of that, but I had very little to do with the substance of that, Mr. Barrows.

Q. Did you go down to Charleston, to Dr. Curme, when he prepared his draft of it? A. Yes, I was in Charleston at that time.

Q. And you went over with him the records of the work that he said that he had considered at that time? A. No, that was provided to him by the men in the laboratories. I was more concerned in my duties with him in Charleston at that time in discussing the prior art, which he discusses in that affidavit.

Q. Mr. Boynton, I show you Defendant's Exhibit 4, which is the file wrapper of the Reissue application (handing exhibit to witness). I call your attention to page 2 of the Specification of the application as filed, and ask you if the statement of the object of the invention which is given there is your statement of the object, one which you prepared? A. Yes, I wrote that.

Q. On page 1 of this reissue application, Mr. Boynton, you will note at the bottom of the page a reference to silver powder or silver wire gauze as examples of the preferred catalyst? A. You mean on page 2, don't you?

Mr. Barrows: Page 2 near the bottom.

A. Yes.

Q. And do you recall that in the original Lefort patent silver powder and silver gauze was also mentioned in Example 2? A. That is correct.

Q. Now, I show you the file wrapper of the Francon application, which I understood you to say was the one that was assigned at the same time as the Lefort patent, and of which you took over the prosecution, is that correct? A. That is correct.

Q. And the amendment which I show you and which was filed in the Patent Office on November 28, 1936, and which is signed with the name of Mr. Greenwald, is one that you prepared? A. May I see it, please? (Paper handed witness by Mr. Barrows.) Yes, Mr. Greenwald is the head of the patent department, and he with Mr. Sheffler, our general patent counsel, hold the power of attorney in probably 90 per cent. of the cases we prosecute, but I prepared that * * * [926-934].

* * * Q. Mr. Boynton, in this amendment I have referred to, and in discussing the original Lefort patent, you said that the Lefort patent mentioned two physical forms in which the catalytic material may be used, one of these is, "wire gauze" and the other is "powder form, as mentioned at lines 28 and 29, page 2, column 1, of the patent." And, further on in that same paragraph you said, "The term 'powder' almost without exception and invariably as applied to metals connotes something which has been ground, or in which the particles are more or less spheroidal."

That is the representation which you made to the Patent Office in this amendment, is it not, under date of November 28, 1936? A. I prepared this amendment.

Q. And you find there the statements I have quoted? A. Yes, I find them.

Q. How old are you, Mr. Boynton? A. Thirty-one.

Mr. Barrows: That's all.

REDIRECT EXAMINATION.

By Mr. Watson:

Q. How long have you been in the patent department of the plaintiff company? A. Ten years.

Q. Was the subject of this Francon application a special physical form of silver lamina torn in sheets of extreme thinness? A. Yes, it had to do with the proposition of beating the metal foil, silver foil, into extremely thin sheets and tearing it into very small pieces so as to form thin small flat particles.

Q. When you prepared and prosecuted the reissue patent in suit did you exclude the use of silver gauze? A. Oh, no. I thought that the term "finely divided" said in one phrase practically everything that had been said about silver, which was said a great many times throughout the original Lefort application—or, rather, the original Lefort patent, and which includes—well, it would include a silver gauze or any other physically prepared form of silver which is fine, like ground up metal, powder, and chemically precipitated silver, such as that silver colloid which was in the third example, being formed by chemical precipitation and it would include chemically prepared silver in various forms, because when he said that he would use silver on a support, it is very difficult to imagine hammered out or ground up silver being so applied.

Q. Do you know whether your company has ever used the particular silver catalyst of that Francon application? A. I am sure we have not.

Mr. Watson: That is all.

The Court: Where did you study? Did you go to any engineering school first?

A. Yes, I did.

The Court: Where?

A. I graduated from Armour Institute of Technology as a chemical engineer.

The Court: And then where did you take your law?

A. New Jersey Law School, Newark, New Jersey.

The Court: That's all.

Mr. Barrows: One more question: Mr. Boynton, you know about these experiments that were carried out early in 1936 using first a silver gauze in which no conversion or formation of ethylene oxide is obtained, and then using silver gauze as a carrier or support by depositing an extra surface on that, you are familiar with those experiments, are you not?

A. Yes, I first saw the results of those at the same time you did, Mr. Barrows, or perhaps a day before you saw them.

Mr. Barrows: That's all.

• • • [936-939].

• • • • • •

Thereupon——

EMORY P. BOYNTON, a witness, recalled by the Court, testified further as follows:

By the Court:

Q. Will you state just briefly, Mr. Boynton, what you thought the Reissue patent or the original patent ought to claim which it did not claim and which you sought to put into the Reissue claim? A. I thought that Mr. Lefort had made an invention which probably should have entitled him to far broader claims than were ever advanced in either of his applications and at one time, when I first wrote the Reissue application and first filed it, I had in mind trying to get that invention secured for him because he obviously had done something that had been—everyone had been near it but no one had actually hit upon this direct oxidation of ethylene to ethylene oxide. It was a totally new sort of chemical reaction. On studying the matter further and particularly after the first Reissue application was filed, it was apparent that because of the way that the French solicitor

had prepared the original U. S. Application from these French patents that it would be virtually impossible to claim the invention broadly so as to cover it whether or not water was even present, added or introduced or formed and with any catalyst and in the scope that an absolutely basic invention should be entitled to be protected. So it was plain then that because of the nature of the patent handling rather than his invention that it would have to be an invention which was clearly within the original disclosure and within his original statement of invention and that was to cover the oxidation of ethylene to form ethylene oxide directly by oxidation with molecular oxygen in the presence of a catalyst and in the presence of water and the catalyst had to be one of those that was named by him and it was perfectly obvious from the original specification that silver or silver modified slightly or something closely akin to silver would have to be the catalyst.

Q. As a matter of fact, you narrowed the catalyst situation in the Reissue, didn't you? A. Yes, it was the intention to do that.

Q. You did not broaden the situation as to the catalyst, you rather narrowed it? A. Yes, he had no real foundation so I found for including certain of these catalysts that were named in his specification and rather than have in there a possible confusion to anyone looking at the specification, it was a case of narrowing down that disclosure of the catalyst and covering them in the claims commensurate with that revised description of the catalyst.

Q. In working this up, did you have the benefit of the help or advice of any technicians other than those who have been here to testify? A. I did not even have the benefit of the help of all of those because Professor Stevenson and Professor Lamb, who testified for the plaintiff here, were not associated with us at that time, but Doctor Curme and Doctor Law and Doctor Perkins were available and I had, of course, consulted with Mr. Watson's firm, Mr. Watson and Mr. Johnson, in that connection * * * [1003-1006].

Reissued May 18, 1937 Re. 20,370

UNITED STATES PATENT OFFICE

20,370

PROCESS FOR THE PRODUCTION OF ETHYLENE OXIDE

Theodore Emile Lefort, Paris, France, assignor, by mesne assignments, to Carbide and Carbon Chemicals Corporation, New York, N. Y., a corporation of New York

No Drawing. Original No. 1,998,878, dated April 23, 1935, Serial No. 699,378, March 22, 1933. Application for reissue September 25, 1936, Serial No. 102,613. In France March 27, 1931

9 Claims. (Cl. 260—54)

This invention provides a specific and novel process for making ethylene oxide. It essentially consists in causing ethylene to combine directly with molecular oxygen at temperatures of about 150° to about 400° C. in the presence of a surface catalyst which favors the oxidation of ethylene to ethylene oxide under these conditions. The process can be carried out at atmospheric pressure, and it may also be conducted at pressures above or below atmospheric pressure.

This process is characterised by an entirely unique reaction in which the direct addition of a single oxygen atom to the ethylene molecule occurs without the formation of significant amounts of other oxygenated compounds such as aldehydes. This novel reaction may be expressed as:

$$2CH_2{=}CH_2 + O_2 \longrightarrow 2CH_2{-}CH_2 \quad (O)$$

and it is accompanied by complete oxidation of some of the ethylene to give carbon dioxide and water according to the equation:

$$CH_2{=}CH_2 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

Ethylene from any desired source may be used, including that obtained from coke oven gas, hydrogenation of acetylene, or dehydration of ethyl alcohol. The oxygen can be the oxygen of the air, and can conveniently be mixed with the ethylene prior to the reaction.

The oxidation of ethylene takes place with a giving off of heat, and it is, of course, desirable to maintain the temperature of the zone of reaction within the range specified. This can be facilitated by suitable dilution of the reaction gases, such as that accomplished by the use of air as the source of oxygen, and some water or carbon dioxide in addition to that formed can be admitted to the mixture in the reaction zone if desired. Hydrogen may be similarly added.

The process can be conveniently conducted by passing a mixture containing air and ethylene through a tube, for example, of silica or of a material capable of withstanding high pressures, within which is placed such a surface catalyst as one composed of silver in finely divided form, and which may be disposed within the tube on a supporting material, or in other known ways. The temperature of the reaction zone is maintained between about 150° and about 400° C., for example, at about 200° C., and the issuing products from the tube contain ethylene oxide, carbon dioxide and water without objectionable aldehydes. The ethylene oxide can be recovered in any suitable way, preferably in liquid form by condensation or solution.

The surface catalyst is preferably silver as stated, but other metals such as bismuth and antimony may be used. Likewise oxides of these metals or mixtures containing these metals or their oxides may be used. Experiments have also indicated that the catalyst may be silver activated by the addition of small amounts of gold or copper or iron.

In any case, the ethylene and oxygen are thus reacted simultaneously at the temperatures set forth in the presence of a surface catalyst and of water, and the process is conducted to produce ethylene oxide as a direct product in substantial and economic amount. The ethylene oxide can be recovered by known methods, and it may be further reacted to form ethylene glycol or derivatives of ethylene glycol.

I claim:

1. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water at a temperature between 150° and 400° C. in the presence of a catalyst composed of silver activated by small quantities of a metal selected from a group consisting of gold, copper and iron.

2. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of the oxygen and water at a temperature between 150° and 400° C. in the presence of a catalyst composed of a mixture of silver, gold, copper and iron.

3. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water at a temperature between 150° C. and 400° C. in the presence of a catalyst composed of a mixture of silver and gold.

4. A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen and steam at a temperature between 150° and 400° C., and at a pressure below atmospheric pressure, in the presence of a catalyst composed of a metal selected from a group consisting of silver, gold, copper and iron, and in the presence of hydrogen in the proportion of 5 per cent of the total volume.

5. A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen and steam at a pressure below atmospheric pressure, in the presence of a catalyst composed of a metal selected from a group consisting of silver, gold, copper

and iron, and in the presence of hydrogen in the proportion of 5 per cent of the total volume, and of CO_2.

6. A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen, steam and hydrogen at a temperature between 150° and 400° C. in the presence of a catalyst composed of silver activated with small quantities of gold.

7. A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen, steam and hydrogen at a temperature between 150° and 400° C. in the presence of a catalyst composed of silver activated with small quantities of a mixture of gold and copper.

8. The process of making ethylene oxide by the direct chemical combination of oxygen with ethylene in the proportions of one atom of oxygen to one molecule of ethylene, which comprises forming a mixture containing ethylene and molecular oxygen and conducting said mixture through a confined reaction zone which is maintained at an elevated temperature; controlling said temperature to maintain said mixture in said zone at a temperature between about 150° and about 400° C.; subjecting said mixture in said zone at said elevated controlled temperature to intimate contact with an active surface catalyst of a material having the catalytic characteristics of silver which favors the direct oxidation of said ethylene in said mixture by said molecular oxygen to form oxidation products containing ethylene oxide in the presence of water and which does not favor the existence in said products of substantial amounts of aldehydes; correlating the passage of said mixture through said reaction zone in the presence of said catalyst and the controlled elevated temperature of said mixture and said catalyst to effect said oxidation of said ethylene directly to form substantial amounts of ethylene oxide; and thereafter recovering ethylene oxide-containing product in liquid form.

9. The process of making ethylene oxide by the direct chemical combination of oxygen with ethylene in the proportions of one atom of oxygen to one molecule of ethylene, which comprises forming a mixture containing ethylene and molecular oxygen and a heat-absorbing diluent and conducting said mixture through a confined reaction zone which is maintained at an elevated temperature; controlling said temperature to maintain said mixture in said zone at a temperature between about 150° and about 400° C.; subjecting said mixture at said elevated controlled temperature to intimate contact with an active surface catalyst material composed essentially of silver which favors the direct oxidation of said ethylene in said mixture by said molecular oxygen to form oxidation products containing ethylene oxide in the presence of water and which does not favor the existence in said products of substantial amounts of aldehydes; correlating the passage of said mixture through said reaction zone in the presence of said catalyst and the controlled elevated temperature of said mixture and said catalyst to effect said oxidation of said ethylene directly to form substantial amounts of ethylene oxide; and thereafter separating ethylene oxide from the products of oxidation.

THEODORE EMILE LEFORT.

PLAINTIFF'S EXHIBIT 7

DISTRICT COURT OF THE UNITED STATES

FOR THE DISTRICT OF MARYLAND.

CARBIDE AND CARBON CHEMICALS CORPORATION, *Plaintiff*, *vs.* U. S. INDUSTRIAL CHEMICALS, INC., *Defendant*.	Civil Action File No. 249

STATEMENT BY DEFENDANT.

In compliance with a request of counsel for plaintiff, defendant admits, for the purposes of this case as follows, and plaintiff accepts this admission in lieu of resort to other pre-trial discovery of acts of defendant alleged by plaintiff to constitute infringement of Reissue Letters Patent No. 20,370.

Subsequent to the grant of said patent, and after notice of plaintiff's asserted rights thereunder, and prior to the filing of the complaint herein, defendant engaged in the commercial production of ethylene glycol in its manufacturing plant at Baltimore, Maryland. In doing so, defendant employed a chamber containing a catalyst consisting of silver disposed upon a carrier of aluminum oxide bonded by a fusion process. A gaseous mixture containing ethylene and the constituents of atmospheric air was passed continuously through this chamber in intimate contact with said catalyst during an extended period of time.

The gaseous mixture entering the chamber contained usually about 1.5% by volume of water vapor, not exceeding 1.7% by volume at any time.

Throughout the operation the temperature within the said chamber was maintained between about 150° and about 400° C.

The ethylene and oxygen in the gaseous mixture reacted within the chamber, in the presence of the catalyst, to produce ethylene oxide in substantial amount; and the resultant gaseous mixture, containing the said oxide and no substantial amounts of aldehydes, passed out of the said chamber continuously during the operation. The said resultant gaseous mixture contained usually about 3.5% by volume of water vapor, not exceeding 3.7% by volume at any time.

Thereafter, the ethylene oxide was dissolved out of the said resultant gaseous mixture by passing said mixture into an acidified aqueous medium, and was reacted in the solution to form ethylene glycol.

L. A. WATSON
Counsel for Plaintiff,

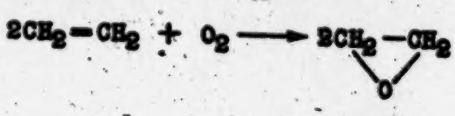
Dated: April 11, 1940

PENNIE, DAVIS, MARVIN & EDMONDS
Counsel for Defendant.

Defendant's Operation

"The ethylene and oxygen in the gaseous mixture reacted within the chamber, in the presence of the catalyst, to produce ethylene oxide . . ."

Thus there was direct chemical combination of oxygen with ethylene in the proportions of one atom of oxygen to one molecule of ethylene to make one molecule of ethylene oxide, according to the equation



"A gaseous mixture containing ethylene and the constituents of atmospheric air . . ."

The constituents of atmospheric air include molecular oxygen having the formula O_2.

"was passed continuously through this chamber . . ."

"Throughout the operation the temperature within said chamber was maintained between about 150° and about 400° C."

Said gaseous mixture was "in intimate contact with said catalyst" and "reacted within the chamber".

"a catalyst consisting of silver disposed upon a carrier of aluminum oxide bonded by a fusion process".

"The ethylene and oxygen in the gaseous mixture reacted within the chamber, in the presence of the catalyst, to produce ethylene oxide in substantial amount; and the resultant gaseous mixture, containing the said oxide and no substantial amounts of aldehydes, passed out of said chamber continuously during the operation."

"The said resultant gaseous mixture contained usually about 3.5% by volume of water vapor,"

"The gaseous mixture entering the chamber contained usually about 1.5% by volume of water vapor,"

Said gaseous mixture "was passed continuously through this chamber in intimate contact with said catalyst during an extended period of time".

"Throughout the operation the temperature within the said chamber was maintained between about 150° and about 400° C."

"The ethylene and oxygen in the gaseous mixture reacted within the chamber, in the presence of the catalyst, to produce ethylene oxide in substantial amount;"

"Thereafter, the ethylene oxide was dissolved out of said resultant gaseous mixture by passing said mixture into an acidified aqueous medium, and was reacted in the solution to form ethylene glycol".

This medium was in liquid form and contained the ethylene oxide.

Plaintiff's Exhibit 8

CLAIM 8 of Reissue 20,370

The process of making ethylene oxide by the direct chemical combination of oxygen with ethylene in the proportions of one atom of oxygen to one molecule of ethylene,

which comprises forming a mixture containing ethylene and molecular oxygen

and conducting said mixture through a confined reaction zone

which is maintained at an elevated temperature; controlling said temperature to maintain said mixture in said zone at a temperature between about 150° and about 400° C.;

subjecting said mixture in said zone at said elevated controlled temperature to intimate contact with an active surface catalyst

of a material having the catalytic characteristics of silver which favors the direct oxidation of said ethylene in said mixture by said molecular oxygen to form oxidation products containing ethylene oxide in the presence of water and which does not favor the existence in said products of substantial amounts of aldehydes;

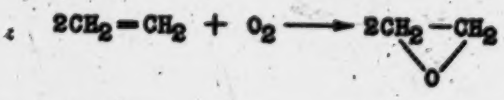
correlating the passage of said mixture through said reaction zone in the presence of said catalyst and the controlled elevated temperature of said mixture and said catalyst to effect said oxidation of said ethylene directly to form substantial amounts of ethylene oxide;

and thereafter recovering ethylene oxide-containing product in liquid form.

Defendant's Operation

"The ethylene and oxygen in the gaseous mixture reacted within the chamber, in the presence of the catalyst, to produce ethylene oxide . . ."

Thus there was direct chemical combination of oxygen with ethylene in the proportions of one atom of oxygen to one molecule of ethylene to make one molecule of ethylene oxide, according to the equation



"A gaseous mixture containing ethylene and the constituents of atmospheric air . . ."

"The gaseous mixture entering the chamber contained usually about 1.5% by volume of water vapor,"

The constituents of atmospheric air include molecular oxygen having the formula O_2 and substantial amounts of nitrogen, a diluent.

"was passed continuously through this chamber . . ."

"Throughout the operation the temperature within said chamber was maintained between about 150° and about 400° C."

Said gaseous mixture was "in intimate contact with said catalyst" and "reacted within the chamber".

"a catalyst consisting of silver disposed upon a carrier of aluminum oxide bonded by a fusion process".

"The ethylene and oxygen in the gaseous mixture reacted within the chamber, in the presence of the catalyst, to produce ethylene oxide in substantial amount; and the resultant gaseous mixture, containing the said oxide and no substantial amounts of aldehydes, passed out of said chamber continuously during the operation."

"The said resulfant gaseous mixture contained usually about 3.5% by volume of water vapor,"

"The gaseous mixture entering the chamber contained usually about 1.5% by volume of water vapor,"

Said gaseous mixture "was passed continuously through this chamber in intimate contact with said catalyst during an extended period of time".

"Throughout the operation the temperature within the said chamber was maintained between about 150° and about 400° C."

"The ethylene and oxygen in the gaseous mixture reacted within the chamber, in the presence of the catalyst, to produce ethylene oxide in substantial amount;"

"Thereafter, the ethylene oxide was dissolved out of said resultant gaseous mixture by passing said mixture into an acidified aqueous medium, and was reacted in the solution to form ethylene glycol".

Plaintiff's Exhibit 9

CLAIM 9 of Reissue 20,370

The process of making ethylene oxide by the direct chemical combination of oxygen with ethylene in the proportions of one atom of oxygen to one molecule of ethylene,

which comprises forming a mixture containing ethylene and molecular oxygen and a heat-absorbing diluent

and conducting said mixture through a confined reaction zone

which is maintained at an elevated temperature; controlling said temperature to maintain said mixture in said zone at a temperature between about 150° and about 400° C.;

subjecting said mixture in said zone at said elevated controlled temperature to intimate contact with an active surface catalyst

material composed essentially of silver which favors the direct oxidation of said ethylene in said mixture by said molecular oxygen to form oxidation products containing ethylene oxide in the presence of water and which does not favor the existence in said products of substantial amounts of aldehydes;

correlating the passage of said mixture through said reaction zone in the presence of said catalyst and the controlled elevated temperature of said mixture and said catalyst to effect said oxidation of said ethylene directly to form substantial amounts of ethylene oxide;

and thereafter separating ethylene oxide from the products of oxidation.

Patented Apr. 23, 1935

1,998,878

UNITED STATES PATENT OFFICE

1,998,878

PROCESS FOR THE PRODUCTION OF ETHYLENE OXIDE

Théodore Emile Lefort, Paris, France, assignor to Société Anonyme; Societe Francaise de Catalyse Generalisee, Paris, France

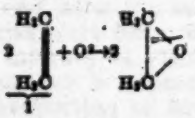
No Drawing. Application March 22, 1932, Serial No. 600,578. In France March 27, 1931

7 Claims. (Cl. 260—156.5)

REISSUED

This invention has for object a process for the production of ethylene oxide which mainly consists in subjecting ethylene to the simultaneous action of the oxygen of air and of water, in presence of a catalyzer and, if need be, of hydrogen.

Hydrogen, in case it is employed, in contact with the catalyzer, probably plays the part of an agent for accelerating the reaction which can be written as follows:



This reaction takes place at atmospheric pressure but, for commercially carrying the said process into practice, pressure can be employed, for instance a pressure of 50 kilograms per square centimeter, at a temperature between 150 and 400° C.

The following catalyzers may be used:

(1) A mixture of antimony, bismuth, silver, lead, arsenic, nickel and tin, in variable proportions.

(2) Silver alone.

(3) Silver activated by introducing therein small proportions of gold, copper or iron.

(4) The metals: gold, copper, iron, separately or in admixture and in any proportions.

(5) Silver alone, bismuth alone and antimony alone.

(6) The following mixtures:

Silver, gold, copper, iron	in any proportions
Silver, gold, copper	
Silver, gold	
Silver, copper, iron	
Silver, copper	
Silver, iron	
Copper, iron	

(7) The mixtures of antimony, lead, nickel and silver.

(8) The mixtures of bismuth, nickel, silver and lead.

(9) The mixtures of antimony, bismuth, nickel.

(10) The mixtures of antimony, bismuth, silver.

(11) The mixtures of bismuth and nickel.

(12) The mixtures of bismuth and silver.

And, generally speaking, all the mixtures which can be obtained with the following metals: antimony, lead, bismuth, silver, nickel, tin, arsenic, gold, copper, iron, taken separately, taken two by two, three by three, four by four, etc. . . . in variable proportions, the mixtures, in the same conditions, of these metals with their oxides, the mixtures of the oxides alone of these metals, in the same conditions.

The ethylene can be obtained from any source of supply: gas from coke ovens, hydrogenation of acetylene, dehydration of ethyl alcohol, and the like.

Water can be admitted in the reaction vessel, either in the liquid state, or as steam.

The oxygen can be the oxygen of the air, this latter gas being introduced in the reaction.

The efficiency of the reaction is increased by diminishing the CO_2 which is formed, by introduction, in this reaction, of a suitable quantity of water: A suitable volume of CO_2 can also be previously introduced in the reacting gases.

For increasing the yield in ethylene oxide, the process can also be carried out under a pressure lower than atmospheric pressure.

Experiments have shown that silver could be activated by introducing, in this body, small quantities either of gold, or of copper, or of iron.

Thus, a mixture containing silver, gold, copper and iron, gives very satisfactory results and allows a specific reaction; the only foreign product obtained in the reaction is CO_2 which can be easily removed. Aldehydes formed exist only as traces.

Moreover, the applicant has found that the reaction giving CO_2 is, contrarily to previous belief, a reaction of oxidation independent from that giving ethylene oxide and from that giving aldehydes. From experiments effected by the applicant, it results that, if water is introduced in suitable quantity, the reaction is not only facilitated, as above stated, but, in addition, the reaction giving CO_2 probably by direct oxidation of ethylene according to the equation:

$$C_2H_4+3O_2=2H_2O+2CO_2$$

is checked, owing, as is probable, to the partial pressure of water. From these experiments, it can be concluded that if a certain quantity of CO_2 is previously introduced, in addition, in the reacting gases, the partial pressure of CO_2 will produce its effect, and the reaction of oxidation of ethylene into CO_2 will be completely checked resulting in a considerable increase in the efficiency of the operation. Moreover, it is to be noted that, when the synthetic operation is effected under partial vacuum, the yield in ethylene oxide is increased.

Several modi operandi for carrying the process

into practice, will be indicated hereinafter, by way of example only.

Modus operandi I

In a plant constructed for resisting to high pressures, ethylene on the one hand, and air on the other hand, are separately compressed by means of suitable compressors.

The mixture of air and ethylene can also be compressed by taking the necessary precautions in order to avoid the risk of explosion.

These two gases will be led, together with hydrogen or not, into a reaction tube resisting to the pressure of several hundreds of kilograms, containing one of the catalysers indicated above, and heated, for instance, to a temperature of 200° C. This tube communicated moreover with a circulating pump allowing to introduce water under pressure.

The reaction will take place in this tube between ethylene, the oxygen of air, and water. By controlling the outputs, a continuous operation will be obtained. Ethylene oxide thus formed will be separated from the other gases, for instance, by condensation.

Modus operandi II

Silver in powder form, or in the form of a wire gauze, and placed or not on a support or carrier, is introduced in a tube, made for instance of silica, and, after the said tube has been heated to a temperature comprised between 150 and 400° C., a mixture of ethylene, air, water vapour, and hydrogen is caused to pass therethrough. The proportion of hydrogen is about 5% of the total mixture. The ethylene oxide produced can be separated from the gases issuing from the tube.

Modus operandi III

A silver colloid is introduced in a high pressure tube which has been filled with water. Pure ethylene under pressure is then added in order that it can dissolve in the water.

The tube is subsequently heated between 150 and 400° C., then air and hydrogen are slowly introduced. The introduction of air is stopped when the totality of ethylene is converted into ethylene oxide.

From ethylene oxide produced according to the processes which have been indicated above, it is possible to obtain, by simple saponification, ethylene-glycol, or by other known methods, any derivative of ethylene-glycol.

The reaction, for obtaining ethylene-glycol, can be written as follows:

$$C_2H_4O + H_2O \rightarrow \begin{matrix} H_2C-OH \\ H_2C-OH \end{matrix}$$

The experiments effected by the applicant have shown that, in presence of the catalysers indicated, water, in the form of steam or not, considerably promotes the reaction ensuring the production of ethylene oxide.

What I claim as my invention and desire to secure by Letters Patent is:

1. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, in presence of a catalyst, constituted by silver activated by introducing in the body small quantities of a metal selected from a group consisting of gold, copper, and iron, at a temperature between 150 and 400° C.

2. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of the oxygen and water, in presence of a catalyst, constituted by a mixture of silver, gold, copper and iron, at a temperature between 150 and 400 degrees C.

3. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, in presence of a catalyst constituted by a mixture of silver and gold, at a temperature between 150 and 400° C.

4. A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen and steam, in presence of a catalyst constituted by a metal selected from a group consisting of silver, gold, copper and iron, and hydrogen in the proportion of 5 per cent of the total volume, at a temperature between 150 and 400 degrees C., and at a pressure below atmospheric pressure.

5. A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen and steam, in presence of a catalyst constituted by a metal selected from a group consisting of silver, gold, copper and iron, and hydrogen in the proportion of 5 per cent of the total volume, and CO_2, and at a pressure below atmospheric pressure.

6. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen, steam and hydrogen in presence of a catalyst constituted by silver activated with small quantities of gold, at a temperature between 150 and 400 degrees C.

7. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen, steam and hydrogen in presence of a catalyst constituted by silver activated with small quantities of a mixture of gold and copper at a temperature between 150 and 400 degrees C.

THEODORE EMILE LEFORT.

Defendant's Exhibit 3

285

ETATS-UNIS D'AMÉRIQUE

600578

MAR 31 1932

DIVISION 8

PETITION.

TO THE COMMISSIONNER OF PATENTS :

Your petitioner Théodore Emile LEFORT *residing at* PARIS (France)

a *citizen* ~~subject~~ *of* the Republic of France

and whose Post Office Address is 8 Avenue Percier, PARIS (France)

INSERT

prays that Letters Patent may be granted to him *for the improvement* s *in* a process for the production of ethylene oxide, particularly for the preparation of ethylene-glycol and of its derivatives *set forth in the annexed Specification.*

And he hereby appoint s Marks & Clerk a firm composed of G. C. Marks, P. Clerk & M. A. Adam, national Press Bldg. Washington, D.C. his

Attorneys with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to sign the drawings, to receive the Letters Patent, and to transact all business in the United States Patent Office connected therewith.

Signed at Paris *this* 11th March 1932

Théodore Emile Lefort (1) *Signature*

SPECIFICATION.

TO ALL WHOM IT MAY CONCERN :

BE IT KNOWN that I, Théodore Emile LEFORT

a *citizen* ~~subject~~ *of* the Republic of France

residing at PARIS (France)

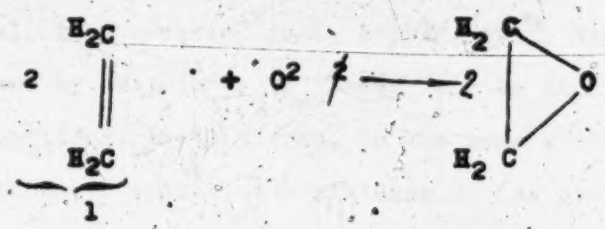
have invented certain new and useful improvements in a process for the production of ethylene oxide, ~~particularly for the preparation of ethylene-glycol and of its derivatives~~

of which the following is a Specification :

600578

This invention has for object a process for the production of ethylene oxide which mainly consists in subjecting ethylene to the simultaneous action of the oxygen of air and of water, in presence of a catalyser and, if need be, of hydrogen.

Hydrogen, in case it is employed, in contact with the catalyser, probably plays the part of an agent for accelerating the reaction which can be written as follows :



This reaction takes place at atmospheric pressure but, for commercially carrying the said process into practice, pressure can be employed, for instance a pressure of 50 kilograms per square centimeter, at a temperature between 150 and 400° C.

The following catalysers may be used :

(1°) A mixture of antimony, bismuth, silver, lead, arsenic, nickel and tin, in variable proportions.

(2°) Silver alone.

(3°) Silver activated by introducing therein small proportions of gold, copper or iron.

(4°) The metals : gold, copper, iron, separately or in admixture and in any proportions.

(5°) Silver alone, bismuth alone and antimony alone.

(6°) The following mixtures :

- Silver, gold, copper, iron,
- Silver, gold, copper,
- Silver, gold,
- Silver, copper, iron,
- Silver, copper,
- Silver, iron,
- Copper, iron,

} in any proportions

(7°) The mixtures of antimony, lead, nickel and silver,

(8°) The mixtures of bismuth, nickel, silver and lead.

(9°) The mixtures of antimony, bismuth, nickel.

(10°) The mixtures of antimony, bismuth, silver.

(11°) The mixtures of bismuth and nickel.

(12°) The mixtures of bismuth and silver.

And, generally speaking, all the mixtures which can be obtained with the following metals : antimony, lead, bismuth, silver, nickel, tin, arsenic, gold, copper, iron, taken separately, taken two by two, three by three, four by four, etc... in variable proportions, the mixtures, in the same conditions, of these metals with their oxides, the mixtures of the oxides alone of these metals, in the same conditions.

The ethylene can be obtained from any source of supply : gas from coke ovens, hydrogenation of acteylene, dehydration of ethyl alcohol, and the like.

Water can be admitted in the reaction vessel, either in the liquid state, or as steam.

The oxygen can be the oxygen of the air, this latter gas being introduced in the reaction.

The efficiency of the reaction is increased by diminishing the CO_2 which is formed, by introduction, in this reaction, of a suitable quantity of water. A suitable volume of CO_2 can also be previously introduced in the reacting gases.

For increasing the yield in ethylene oxide, the process can also be carried out under a pressure lower than atmospheric pressure.

Experiments have shown that silver could be activated by introducing, in this body, small quantities either of gold, or of copper, or of iron.

Thus, a mixture containing silver, gold, copper and iron, gives very satisfactory results and allows a specific reaction; the only foreign product obtained in the reaction is CO_2 which can be easily removed. Aldehydes formed exist only as traces.

Defendant's Exhibit 3 (Continued)

Moreover, the Applicant has found that the reaction giving CO_2 is, contrarily to previous belief, a reaction of oxidation independent from that giving ethylene oxide and from that giving aldehydes. From experiments effected by the Applicant, it results that, if water is introduced in suitable quantity, the reaction is not only facilitated, as above stated, but, in addition, the reaction giving CO_2, probably by direct oxidation of ethylene according to the equation :

$$C_2H_4 + 3\ O_2 = 2\ H_2O + 2\ CO_2$$

is checked, owing, as is probable, to the partial pressure of water. From these experiments, it can be concluded that if a certain quantity of CO_2 is previously introduced, in addition, in the reacting gases, the partial pressure of CO_2 will produce its effect, and the reaction of oxidation of ethylene into CO_2 will be completely checked resulting in a considerable increase in the efficiency of the operation. Moreover, it is to be noted that, when the synthetic operation is effected under partial vacuum, the yield in ethylene oxide is increased.

Several modi operandi for carrying the process into practice, will be indicated hereinafter, by way of example only.

MODUS OPERANDI

In a plant constructed for resisting to high pressures, ethylene on the one hand, and air on the other hand, are separately compressed by means of suitable compressors.

The mixture of air and ethylene can also be compressed by taking the necessary precautions in order to avoid the risk of explosion.

These two gases will be led, together with hydrogen or not, into a reaction tube resisting to the pressure of several hundreds of kilograms, containing one of the catalysers indicated above, and heated, for instance, to a temperature of 200 ° C. This tube communicated moreover with a circulating pump, allowing to introduce water under pressure.

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The reaction will take place in this tube between ethylene, the oxygen of air, and water. By controlling the outputs, a continuous operation will be obtained. Ethylene oxide thus formed will be separated from the other gases, for instance, by condensation.

MODUS OPERANDI II

Silver in powder form, or in the form of a wire gauze, and placed or not on a support or carrier, is introduced in a tube, made for instance of silica, and, after the said tube has been heated to a temperature comprised between 150 and 400° C, a mixture of ethylene, air, water vapour, and hydrogen is caused to pass therethrough. The proportion of hydrogen is about 5 % of the total mixture. The ethylene oxide produced can be separated from the gases issuing from the tube.

MODUS OPERANDI III

A silver colloid is introduced in a high pressure tube which has been filled with water. Pure ethylene under pressure is then added in order that it can dissolve in the water.

The tube is subsequently heated between 150 and 400° C, then air and hydrogen are slowly introduced. The introduction of air is stopped when the totality of ethylene is converted into ethylene oxide.

From ethylene oxide produced according to the processes which have been indicated above, it is possible to obtain, by simple saponification, ethylene-glycol, or by other known methods, a derivative of ethylene-glycol.

The reaction, for obtaining ethylene-glycol, can be written as follows :

$$C_2H_4O + H_2O \longrightarrow \begin{matrix} H_2C - OH \\ | \\ H_2C - OH \end{matrix}$$

The experiments effected by the Applicant have shown that, in presence of the catalysers indicated, water, in the form of steam or not, considerably promotes the reaction ensuring the production of ethylene oxide.

What I claim as my invention and desire to secure by Letters Patent is :

1. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneousaction of oxygen and water, in presence of a catalyst, and, if need be, of hydrogen.

2. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, in presence of a catalyst, constituted by a mixture of antimony, bismuth, silver, lead, arsenic, nickel and tin, at a temperature between 150 and 400° C.

3. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, in presence of a catalyst, constituted by silver, in a powder state or in the shape of a wire-gauze, at a temperature between 150 and 400° C.

4. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, in presence of a catalyst, constituted by silver activated by introducing in the body, small quantities either of gold, or of copper, or of iron, at a temperature between 150 and 400° C.

5. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, in presence of a catalyst constituted by gold, silver, iron alone or mixed, at a temperature between 150 and 400° C.

6. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of the oxygen and water, in presence of a catalyst, constituted by a mixture of silver, gold, copper and iron, at a temperature between 150 and 400 degrees C.

7. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, in presence of a catalyst constituted by a mixture of silver, gold and copper, at a temperature between 150 and 400° C.

8. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, in presence of a catalyst constituted by a mixture of silver and gold, at a temperature between 150 and 400 ° C.

44

9. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, in presence of a catalyst, constituted by a mixture of silver, copper and iron, at a temperature between 150 and 400° C.

10. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, in presence of a catalyst constituted by a mixture of silver and copper, at a temperature between 150 and 400 ° C.

11. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, in presence of a catalyst constituted by a mixture of silver and iron, at a temperature between 150 and 400 ° C.

12. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, in presence of a catalyst constituted by a mixture of copper and iron, at a temperature between 150 and 400° C.

~~13.~~ A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen and steam, in presence of a catalyst and hydrogen in the proportion of 5 per cent of the total volume, at a temperature between 150 and 400 degrees C. and at pressure below atmospheric pressure.

~~14.~~ A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen and steam, in presence of a catalyst and hydrogen in the proportion of 5 per cent of the total volume, and CO_2, and at pressure below atmospheric pressure.

600578

7

Defendant's Exhibit 3 (Continued)

ETATS-UNIS D'AMÉRIQUE

B 292

In testimony whereof I have signed this specification

Théodore Emile Lefort (2) Signature

OATH.

CONSULATE GENERAL ... } ss.

Théodore Emile LEFORT

the above-named petitioner, being duly sworn or affirmed depose s and say s that he is a *citizen* ~~subject~~ *of* the Republic of France

and resident of 8 Avenue Percier, PARIS (France)

that he *verily believes* himself *to be the original, first, and* sole *inventor of the improvements in* a process for the production of ethylene oxide, particularly for the preparation of ethylene-glycol and of its derivatives

described and claimed in the annexed specification; that he *does not know and does not believe that the same was ever known or used before* his *invention or discovery thereof, or patented or described in any printed publication in any country before* his *invention or discovery thereof, or more than two years prior to this application, or in public use or on sale in the United States for more than two years prior to this application; that said invention has not been patented in any country foreign to the United States on an application filed by* him *or* his *legal representatives or assigns more than twelve months prior to this application; and that no application for patent on said improvement has been filed by* him *or* his *representatives or assigns in any country foreign to the United States except as follows*

- in France on the 27th March 1931,
- " " " " 4th July 1931 (Patent of addition)
- " " " " 11th September 1931 (Patent of Addition)
- " " " " 26th September 1931 (Patent of Addition)
- " " " " 19th December 1931 (Patent of Addition)
- " " " " 3rd October 1931,
- " " " " 19th December 1931 (Patent of Addition)

Théodore Emile Lefort (3) Signature

[redacted] to and subscribed before me this 11th day of March 1932

2398

[redacted] (4)

Vice-Consul of the United States
U. S. Consul

AMERIC[redacted]

PAR[redacted]

8

600578

8.

Div. 6 Room 4898C ca/ah Paper No. 2

Address only "The Commissioner of Patents, Washington, D. C." and not any official by name

DEPARTMENT OF COMMERCE
UNITED STATES PATENT OFFICE
WASHINGTON

All communications respecting this application should give the serial number, date of filing, and name of the applicant

Sept. 16, 1932

Please find below a communication from the EXAMINER in charge of this application.

Thomas E. Robertson
Commissioner of Patents.

Applicant: T. E. Lefort

Marks & Clerk
National Press Bldg.
Washington, D. C.

Ser. No. 600,578
Filed Mar. 22, 1932
For Process for the Production of Ethylene Oxide, Particularly for the Preparation of Etc.

MAILED
SEP 16 1932

Examined.

The title should be amended to indicate that applicant's invention resides in the production of ethylene oxide. The hydrolysis of the oxide to ethylene glycol forms no part of applicant's invention, since it is obvious that the oxide derived from any source could be hydrolized.

Division and election of species between the following groups of claims is required in accordance with the provisions of Rule 41:

I. Claim 2 in which a mixture composed of antimony, bismuth, silver, lead, arsenic, nickel and tin is used as a catalyst.

II. Claim 3 in which silver is used.

III. Claim 6 in which a mixture composed of silver, gold, copper and iron is used.

IV. Claim 7 in which a mixture composed of silver, gold and copper is used.

V. Claim 8 in which a mixture composed of silver and gold is used.

VI. Claim 9 in which a mixture composed of silver, copper and iron is used.

VII. Claim 10 in which a mixture composed of silver and copper is used.

VIII. Claim 11 in which a mixture composed of silver and iron is used.

600578

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Serial No. 600,578 - #2.

IX. Claim 12 in which a mixture composed of copper and iron is used.

Claims 1, 13 and 14 are generic to all of the above groups. Claim 4 is generic to groups V, VII and VIII. Claim 5 is generic to group II. However, claims 1, 13 and 14 are rejected as being indefinite and too broad in "catalyst" and claims 4 and 5 are rejected as being alternative in "either of gold, or of copper or of iron" and "alone or mixed". Alternative expressions are not allowed in patent claims. The term "catalyst" does not identify the materials used and is nothing more than a statement of a desired result or affect. There is no invention in the broad idea of using a catalyst in any process.

In the absence of an allowable generic claim only one specie may be claimed. As to a proper response to the requirement for division, if the patentability of the generic claims is urged, applicant's attention is directed to Ex parte Doane, 410 O. G. 275.

W.H.C

A M Lewers
Examiner.

600578 #10

AMENDMENT

IN THE UNITED STATES PATENT OFFICE

T. E. Lefort
Serial No. 600578
Filed March 22, 1932
For: Process for the Production of Ethylene Oxide, Particularly for the Preparation of Ethylene-glycol etc.
Division 6....Room 4808C

Hon. Commissioner of Patents,

Washington, D.C.

Sir:

In response to the official letter of Sept. 16, 1932, please amend the above case as follows:

Change the title of the invention to read: --Process for the Production of Ethylene Oxide.--

Cancel claims 2, 3, 9, 10, 11 and 12.

Claim 1, change the last line to read --and water, in presence of a catalyst, constituted by metal selected from a group consisting of silver, gold, copper and iron, and in presence or hydrogen.--

Claim 4, line 4, change "either" to--of metal selected from a group consisting--. Same line, cancel "or of". Last line, change ", or of" to --and--.

Claim 5, line 3, before "gold" insert --metal selected from a group consisting of--. Same line, change the comma after "silver" to --and--. Last line, cancel "alone or mixed".

Claim 13, line 3, after "catalyst" insert --constituted by metal selected from a group consisting of silver, gold, copper and iron,--.

Claim 14, line 3, after "catalyst" insert --constituted by metal selected from a group consisting or silver, gold, copper and iron,--.

Claim 8, line 3, after "silver" insert --and--?

600578

- R E M A R K S -

The requested division has now been made by cancelling claims 2, 3, 9, 10, 11 and 12. Of the remaining claims, 1, 4, 6, 13 and 14 are generic and three claims, 5, 7 and 8 are specific. The alternatives have been removed and other suitable corrections made in the standing claims. The catalyst has been specified in each of the claims now remaining.

A favorable action is solicited.

Respectfully submitted,

By

Marks & Clerk

Attorneys.

March 15, 1933

GHJ-ED-17168

600578

6/12

12.

SUPPLEMENTAL AMENDMENT

IN THE UNITED STATES PATENT OFFICE

T.E.LEFORT
SER.NO.600578
FILED MARCH 22, 1932
FOR: PROCESS FOR THE PRODUCTION OF ETHYLENE OXIDE, PARTICULARLY FOR THE PREPARATION OF ETHYLENE-GLYCOL ETC.
DIVISION 6 ROOM 4898C

Hon. Commissioner of Patents,

Washington, D.C.

Sir:

In further response to the official action of September 15, 1932, please add the following claims:

--15. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen, steam and hydrogen in presence of a catalyst constituted by silver activated with small quantities of another metal, at a temperature between 150 and 400 degrees C.

16. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen, steam and hydrogen in presence of a catalyst constituted by silver activated with small quantities of gold, at a temperature between 150 and 400 degrees C.

17. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen, steam and hydrogen in presence of a catalyst constituted by silver activated with small quantities of copper, at a temperature between 150 and 400 degrees C.

SC 05718 - 4/13

18. A process for the production or ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen, steam and hydrogen in presence of a catalyst constituted by silver activated with small quantities of a mixture of gold and copper at a temperature between 150 and 400 degrees C.

19. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen, steam and hydrogen in presence of a catalyst constituted by silver activated with small quantities of another metal selected from group I of the periodic system at a temperature between 150 and 400 degrees C. and at a pressure below atmospheric pressure, the proportion of hydrogen being of 5 per cent or the total volume of oxygen and steam. --

- R E M A R K S -

It is respectfully requested that the added claims be considered with the previous amendment.

Respectfully submitted,

By Marks & Clerk
Attorneys.

March.21, 1933

GHJ-ED-17168

600578

Div. 6 Room 4898 C

Paper No. 5

Address only "The Commissioner of Patents, Washington, D. C." and not any official by name

All communications respecting this application should give the serial number, date of filing, and name of the applicant

DEPARTMENT OF COMMERCE
UNITED STATES PATENT OFFICE
WASHINGTON

GA:RW

June 24, 1933.

Please find below a communication from the EXAMINER in charge of this application.

Thomas E. Robertson
Commissioner of Patents.

Applicant: T. E. Lefort

Marks & Clerk,
National Press Bldg.,
Washington, D. C.

Ser. No. 600,578
Filed Mar. 22, 1932
For Process For The Production Of Ethylene Oxide.

MAILED
JUN 24 1933

In response to amendments filed Mar. 16 and 23, 1933.

Additional references:

Skarbloom (British) 369,141 acc. Mar. 17, 1932 260-156.5
Article by Lenher "Jour. Am. Chem. Soc." Vol 53, pages 2420 to 2421 (1931)
Article by Willstatter, "annalen des Chemie" Vol. 422, pages 36 to 46 (1920).

Claims 1 and 5 are rejected upon Willstatter in view of Lenher. Both references disclose the oxidation of ethylene under the same conditions as are used by the applicant. Willstatter discloses the use of metal catalysts such as copper, silver, etc. Lenher discloses that ethylene oxide is one of the products formed. Willstatter discloses the use of inert diluents and the use of steam as a diluent is not therefore considered to involve invention. Skarbloom discloses a similar processes in which the steam is used as a diluent. Willstatter also discloses that steam is present during the reaction.

Claims 4, 5, 13 and 14 are unidiomatic in "by metal". This should be ---by metals---. "Metal" alone is not good English.

Claims 15 and 19 are rejected as being too broad in "another metal". Applicant has not disclosed that all other metals may be used as activators. The claims must be commensurate with the disclosure.

Division is required between the following groups of claims:

16.

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R 15

SHEET NO. 2 Serial No. 600,578

(I) claim 6, catalyst compound of Ag, An, Cu and Fe,

(II) claims 7 and 17, catalyst compound of Ag, An and Cu.,

(III) Claims 8 and 15, catalyst compound of Ag and An; and

(IV) Claim 16, catalyst compound of Ag and Cu.

Not more than three species can be had with an allowable generic claim and four are claimed in this case.

W.H.C.

A M Sievers

EXAMINER.

C

AMENDMENT

IN THE UNITED STATES PATENT OFFICE

T.E. Lefort
Serial No. 600578
Filed March 22,1932
Process for the Production of
Ethylene Oxide.
Division 6....Room 4898C.

Hon. Commissioner of Patents,

Washington, D.C.

Sir:

In response to the official letter of June 24, 1933, please amend the above case as follows:

Cancel claims 1, 5, 7 and 17.

Claims 15 and 19, line 5, after "metal" insert --selected from group I of the periodic system--.

- R E M A R K S -

The requested division has now been made by cancellation of claims 7 and 17 so that only three species are now claimed beside the generic claims 13 and 14.

Claims 1 and 5 which appear to be met by the cited references have been cancelled.

With regard to the requested correction of claims 4, 5, 13 and 14 to change "metal" to -metals-, this change has not been made because it is considered that the claims read better in their present state than they would after such change. In connection herewith it is pointed out that the Markush decision has been applied in said claims in order to avoid the alternative expression "either of gold or of copper or of iron" which occurs in said claims. It will further be noted that the word

17.

1. 600578 #17

"metal" in this case is collective in order to imply that not only one but two or more of the enumerated metals may be used and this is considered perfectly good English. Since no references have been cited against the now standing claims namely, 4, 6, 8, 13, 14, 15, 16, 18 and 19, a favorable action passing the case to issue is solicited.

Respectfully submitted,

By Marbaugh Clark

Attorneys

December 22,1933

GHJ-ED- 17168

600578 / 18

18.

Defendant's Exhibit 3 (Continued)

303

JAN 5 1934
DIVISION 8

JAN-3-34

Letter

SUPPLEMENTAL
AMENDMENT

IN THE UNITED STATES PATENT OFFICE.

T.E.Lefort
Serial No. 600578
Filed March 22, 1932
For: Process for the Production of Ethylene Oxide
Division 6....Room 4898C

Hon. Commissioner of Patents,

Washington, D.C.

Sir:

Please consider the following arguments in connection with the amendment filed Dec. 22, 1933:

The invention defined in the claims now maintained consists in a process of direct oxidation of the ethylene in the presence of oxygen, water (or steam) and hydrogen in the presence of a well-defined catalyst; the silver is activated with small quantities of gold, copper or iron.

The British Patent 369141 cannot be considered a prior publication. It was published on 17th March 1932 while applicant filed the present U.S. application under the Convention with priorities of March 27, 1931.

Lenher shows the secondary reactions which applicant proposes to eliminate in order to increase the yield of ethylene oxide. The catalysts cited by Willstatter do not include silver activated with small quantities of other metals.

A favorable action is solicited.

Respectfully submitted,

By Marks & Clerk
Attorneys.

December 29,1933
GHJ-ED-17163

19.

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~~13~~ 19

Defendant's Exhibit 3 (Continued)

304

DEPARTMENT OF COMMERCE
UNITED STATES PATENT OFFICE
WASHINGTON

Please find below a communication from the EXAMINER in charge of this application.

Mar. 28, 1934

Commissioner of Patents.

Marks & Clerk
National Press Bldg.
Washington, D. C.

Applicant: T. E. Lefort

Ser. No. 600,578
Filed Mar. 22, 1932
For Process for the Production of Ethylene Oxide

MAR 29 1934

Responsive to amendment filed Dec. 22, 1933 and latter filed Jan. 3, 1934, respectively.

Claims 15 and 19 are rejected upon the ground that they have no basis in the disclosure. There was no disclosure that all metals of group I could be used. The metals of this group differ greatly in properties and the disclosure of a few could in no way indicate that all would be useful. Catalysis cannot be predicted.

The requirement that "metal" or "by metal", occurring in claims 4, 13 and 14, be changed to a metal or similar idiomatic English is repeated.

Claims 6, 8, 16 and 18 are allowable so far as now known.

W.H.C.

O. F. Setearns
Acty. Examiner.

600578

20.

IN THE UNITED STATES PATENT OFFICE

In re application

Applicant: T.E.Lefort

Title: Process for the Production of Ethylene Oxide

Ser. No.: 600578

Filed: March 22, 1932

Div. 6 Room 4898C

SUBSTITUTE POWER-OF-ATTORNEY

Hon. Commissioner of Patents,

Washington, D. C.

Sir:

In the matter of the above patent application please substitute Eustace S. Glascock, Wm. Webster Downing and Charles P. Seebold, constituting the firm of Glascock, Downing & Seebold (whose register number is 13992), National Press Building, Washington, D. C., as attorneys in our stead.

Marshall Celeste

September 17, 1934

600578

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AMENDMENT

IN THE UNITED STATES PATENT OFFICE

T. E. Lefort
Serial No. 600578
Filed March 22, 1932
For: Process for the Production of Ethylene Oxide
Division 6...Room 4898C

Hon. Commissioner of Patents,

Washington, D.C.

Sir:

In response to the official letter of March 28, 1934, please amend the above case as follows:

Cancel claims 15 and 19.

D1 Claim 4, rewrite line 4 to read by introducing in the body small quantities of a metal selected from a group consisting of gold,

D2 Claim 13, change line 3 to read gen and steam, in presence of a catalyst constituted by a metal selected from a group consisting of silver, gold, copper and iron, and hydrogen in the pro-

D3 Claim 14, change line 3 to read and steam, in presence of a catalyst constituted by a metal selected from a group consisting of silver, gold, copper and iron, and hydrogen in the proportion

- R E M A R K S -

The rejected claims 15 and 19 having been cancelled and 4, 13 and 14 amended as directed by the Examiner, the case is now considered to be in condition for allowance since claims 6, 8, 16 and 18 have already been declared allowable. The standing and allowed claims are

22.

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accordingly the following: 4, 6, 8, 13, 14, 16 and 18.

An early final action passing the case to issue is respectfully requested.

Respectfully submitted,

By Glassock, Downing & Seebold
Attorneys.

September 17, 1934
GHJ-ED-17168

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600578

46 33

ADDRESS ONLY
THE COMMISSIONER OF PATENTS
WASHINGTON, D. C.
Div. 6-AH

Serial No. 600,578

DEPARTMENT OF COMMERCE
UNITED STATES PATENT OFFICE
WASHINGTON January three, 1935

Theodore Emile Lefort, Assor.,

Your APPLICATION for a patent for an IMPROVEMENT in Process for the Production of Ethylene Oxide

filed Mar. 22, 1932 has been examined and ALLOWED with 7 claims.

The final fee, THIRTY DOLLARS, WITH $1 ADDITIONAL FOR EACH CLAIM ALLOWED IN EXCESS OF 20, must be paid not later than SIX MONTHS from the date of this present notice of allowance. If the final fee be not paid within that period, the patent will be withheld, but the application may be renewed within one year after the date of the original notice with a renewal fee of $30 and $1 additional for each claim in excess of 20.

The office delivers patents upon the day of their date, on which date their term begins to run. The preparation of the patent for final signing and sealing will require about four weeks, and such work will not be begun until after payment of the necessary final fee.

When the final fee is paid, there should also be sent, DISTINCTLY AND PLAINLY WRITTEN, the name of the INVENTOR, TITLE OF THE INVENTION, AND SERIAL NUMBER AS ABOVE GIVEN, DATE OF ALLOWANCE (which is the date of this circular), DATE OF FILING, and, if assigned, the NAMES OF THE ASSIGNEES.

If it is desired to have the patent issue to an ASSIGNEE OR ASSIGNEES, an assignment containing a REQUEST to that effect, together with the FEE for recording the same, must be filed in this office on or before the date of payment of the final fee.

After issue of the patent, uncertified copies of the drawings and specifications may be purchased at the price of TEN CENTS EACH. The money should accompany the order. Postage stamps will not be received.

The final fee will NOT be received from other than the applicant, his assignee or attorney, or a party in interest as shown by the records of the Patent Office.

NOTICE.—WHEN THE NUMBER OF CLAIMS ALLOWED IS IN EXCESS OF 20, NO SUM LESS THAN $30 PLUS $1 ADDITIONAL FOR EACH CLAIM IN EXCESS OF TWENTY CAN BE ACCEPTED AS THE FINAL FEE.

Respectfully,

Commissioner of Patents.

Glascock, Downing & Seebold
National Press Bldg.
Washington, D. C.

600578

24.

IN REMITTING THE FINAL FEE GIVE THE SERIAL NUMBER AT THE HEAD OF THIS NOTICE.

UNCERTIFIED CHECKS WILL NOT BE ACCEPTED.

Defendant's Exhibit 4

309

SEP 25 36 0[illegible] — 30.00

PETITION

102613

TO THE COMMISSIONER OF PATENTS:

Sir:

Your petitioner THEODORE EMILE LEFORT, a citizen of the Republic of France and a resident of Paris in the Department of Seine, whose post office address is 8 Avenue Percier, prays that he may be allowed to surrender the Letters Patent for improvement in PROCESSES FOR THE PRODUCTION OF ETHYLENE OXIDE, No. 1,998,878, granted April 23, 1935, on an application filed by him on March 22, 1932, Serial No. 600,578, whereof Carbide and Carbon Chemicals Corporation, on whose behalf and with whose assent this application is made, is now sole owner, and that Letters Patent may be reissued to said Carbide and Carbon Chemicals Corporation for the same invention upon the annexed amended specification. With this petition is forwarded a request for an abstract of title duly certified to be filed with this petition, as required in such cases,

And he hereby appoints CHARLES C. SCHEFFLER, Register No. 11032, and EUGENE L. GREENEWALD, Register No. 3276, both of 30 East 42nd Street, New York, New York, his attorneys with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the Letters Patent, and to transact all business in the United States Patent Office connected therewith, the said power to be exercised separately or collectively by said attorneys as they shall from time to time elect. Please address all communications to Charles C. Scheffler.

Signed at Paris, France, this tenth day of September, 1936. Theodore Emile Lefort

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The undersigned, assignee of the entire right, title and interest in and to the above-mentioned Letters Patent, hereby assents to the accompanying application.

CARBIDE AND CARBON CHEMICALS CORPORATION

By _____
Vice-President

ATTEST

_____
Secretary

C 111

SPECIFICATION

TO WHOM IT MAY CONCERN:

Be it known that I, THEODORE EMILE LEFORT, a citizen of the Republic of France, residing at 8 Avenue Percier in the City of Paris and Department of Seine, have invented certain new and useful improvements in PROCESS FOR THE PRODUCTION OF ETHYLENE OXIDE, of which the following is a full, clear and exact description, such as will enable others skilled in the art to which it pertains to make and use the same,

IN THE UNITED STATES PATENT OFFICE

SEP 25 1936
U.S. PAT. OFFICE

Honorable Commissioner of Patents,
Washington, D. C.

Sir:

There are transmitted herewith Petition, Specification, and Oath relating to an application for re-issue Letters Patent No. 1,998,878 for improvements in "Processes for the Production of Ethylene Oxide", granted April 23, 1935, to Societe Anonyme; Societe Francaise de Catalyse Generalisee as assignee of Theodore Emile Lefort, and since assigned to Carbide and Carbon Chemicals Corporation.

There is also forwarded herewith a request that a certified copy of the abstract of title of the patent identified in the preceding paragraph be prepared for placement in the file of this application, as required in such cases. We also enclose check No. 208,020 for thirty dollars ($30.00) in payment of the Government fee in re-issue cases.

Annexed hereto are duly certified copies of French Patent No. 729,952, together with Patents of Addition thereto Nos. 41,255; 41,474; 41,484; and 41,810; and French Patent No. 739,562, together with Patent of Addition thereto No.41,811, which Patents and Patents of Addition are those referred to, and identified by the filing dates thereof, in the oath accompanying the original application, Serial No. 600,578, on which was granted United States Patent No. 1,998,878.

The original grant of Letters Patent No. 1,998,878 is not presented at this time, but will be forwarded for surrender at such time as notification is given that the application is otherwise in condition for allowance.

Respectfully submitted,

E. L. Greenwald
Attorney for Applicant

New York, N. Y.
September 23, 1936

28.

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F/K

This invention has for its object a process for the production of ethylene oxide which consists essentially in subjecting ethylene to the action of oxygen of the air in the presence of suitable catalysts at temperatures between about 150° C. and about 400° C. If desired, water or hydrogen or both may be introduced for the purpose of facilitating or accelerating the reaction as more fully hereinafter described.

The main reaction involved in this process may be indicated as:

$$2\ CH_2{:}CH_2 + O_2 = 2\ CH_2.CH_2 \quad (O)$$

This reaction is, so far as I am aware, entirely novel, and the process of this invention for the first time provides a means for making ethylene oxide by the direct oxidation of ethylene, that is, employing molecular oxygen rather than atomic oxygen supplied chemically.

The reaction of my invention takes place at atmospheric pressure, but, if it is commercially desirable, superatmospheric pressures of, say, about 700 pounds per square inch, can be employed. I have also found that the yield of ethylene oxide can be somewhat increased by operating the process at pressures lower than atmospheric pressure.

As catalysts, I prefer to use those comprising or composed of silver, preferably in a form presenting an extended surface, such as silver powder or silver wire gauze. Other catalytic agents may be selected from the following:

(1) A mixture of antimony, bismuth, silver, lead, arsenic, nickel and tin, the proportions of which may vary;

(2) Silver activated by the incorporation therewith of minor proportions of gold, copper or iron;

(3) Gold, copper or iron, alone, or combined in various proportions;

(4) Bismuth and antimony alone;

(5) The following mixtures, in which the constituents may be present in any desired proportions:

Silver, gold, copper and iron,
Silver, gold and copper,
Silver, and gold,
Silver, copper and iron,
Silver, and copper,
Silver, and iron,
Copper, and iron;

(6) Mixture of antimony, lead, nickel and silver;

(7) Mixtures of bismuth, nickel, silver and lead;

(8) Mixtures of antimony, bismuth and silver or nickel; and

(9) Mixtures of bismuth and silver or nickel.

Generally speaking, suitable catalysts can be obtained from the metals: silver, antimony, lead, bismuth, nickel, tin, arsenic, gold, copper and iron, taken in all of their various combinations and in varying proportions. These metals may be used as such, as the oxides, or in various combinations of the metals with the oxides.

The ethylene can be that obtained from any convenient source, such as coke oven gas, hydrogenation of acetylene, dehydration of ethyl alcohol, and the like.

The oxygen used in the process can be oxygen of the air, and it is usually convenient to introduce oxygen by admitting air to the reaction.

Carbon dioxide may be formed in the process by secondary reaction, and the efficiency of the process can be increased by diminishing the tendency toward this secondary oxidation. I have found that the reaction giving carbon dioxide is, contrary to expectations, independent of that giving ethylene oxide, and probably proceeds according to the equation:

$$C_2H_4 + 3O_2 = 2H_2O + 2CO_2.$$

Thus, by introducing water, or a suitable volume of carbon dioxide, or both, with the reaction gases, this reaction is checked. The retarding effect on the total oxidation of ethylene to water and carbon dioxide is probably due to the partial pressures of the water or carbon dioxide added. In some cases, the addition of both water and carbon dioxide completely suppresses the total oxidation of ethylene, resulting in a marked increase in the efficiency of the process. The water, if it is used, may be admitted to the reaction vessel either in the liquid state, or as steam.

My experiments have shown that silver used as a catalyst in this process can be activated by introducing with it, small quantities of gold, or of copper, or of iron. A mixture containing silver, gold, copper and iron gives very satisfactory results, and allows a specific reaction; the only by-product being carbon dioxide which, of course, may be readily separated from the ethylene oxide. Only traces of aldehydes are formed.

Several methods of operation for carrying the process into practice will now be given by way of example only.

I

In suitable apparatus designed to resist high pressures, ethylene and air are separately compressed by means of appropriate compressors. The ethylene and air may also be compressed together, provided adequate precautions are observed to avoid explosion of the mixture.

These two compressed gases are then led together into a reaction tube capable of withstanding high pressures, and which contains a catalyst selected from those mentioned above. The catalyst-containing reaction tube is heated, for instance, to a temperature of 200°C. The reaction tube also communicates with a circulating pump which will permit the introduction of water under pressure.

The reaction will take place between the ethylene and oxygen of the air, and by controlling the flow of materials, the process may operate continuously. The ethylene oxide formed may be separated from the other gases, for instance, by condensation.

II

Silver, in the form of powder or wire gauze, with or without a support or carrier, is introduced into a suitable tube, such as one formed of silica. The tube and catalyst are then heated to between about 150°and 400° C., and a mixture of ethylene, air, water and hydrogen is passed through the tube. The volume of hydrogen used is about 5% of the total mixture.

Ethylene oxide is formed, and can be separated from the gas mixture issuing from the tube.

III

A silver colloid is placed in a high pressure tube which is filled with water. Pure ethylene under pressure is then added to form a solution of ethylene in the water.

The tube is thereafter heated between 150° C. and 400° C., and air and hydrogen are slowly introduced. The addition of air is stopped when all of the ethylene has been oxidized.

The ethylene oxide produced according to the process of this invention can be reacted with water in known manner to yield ethylene glycol, and, by other known methods, it can be converted into various derivatives of ethylene glycol. The reaction by which ethylene glycol is made may be indicated by the equation:

$$C_2H_4O + H_2O = CH_2OH.CH_2OH.$$

My experiments have shown that in the presence of the various catalytic materials indicated above, water, in the form of steam or not, considerably promotes the reaction insuring the production of ethylene oxide.

It will be clear that the process can be varied without departing from the essential teachings, and such modifications are included within my invention as defined by the appended claims.

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I claim:

1. A process for the production of ethylene oxide which comprises subjecting ethylene to the action of oxygen in the presence of a catalyst.

2. A process for the production of ethylene oxide which comprises subjecting ethylene to the action of molecular oxygen in the presence of a catalyst.

3. A process for the production of ethylene oxide which comprises subjecting ethylene to the action of oxygen in the presence of a catalyst at a temperature between about 150° C. and about 400° C.

4. A process for the production of ethylene oxide which comprises subjecting ethylene to the action of oxygen in the presence of a catalyst essentially containing silver.

5. A process for the production of ethylene oxide which comprises subjecting ethylene to the action of oxygen in the presence of a catalyst essentially containing silver activated by the addition of a small proportion of another metal.

6. A process for the production of ethylene oxide which comprises subjecting ethylene to the action of molecular oxygen in the presence of a catalyst essentially containing silver.

7. A process for the production of ethylene oxide which comprises subjecting ethylene to the action of oxygen at a temperature between about 150° C. and about 400° C. in the presence of a catalyst essentially containing silver.

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8. A process for the production of ethylene oxide which comprises subjecting ethylene to the action of oxygen of the air at a temperature between about 150° C. and about 400° C. in the presence of a catalyst essentially containing silver.

9. A process for the production of ethylene oxide which comprises subjecting ethylene to the simultaneous action of oxygen and water in the presence of a catalyst.

10. A process for the production of ethylene oxide which comprises subjecting ethylene to the simultaneous action of oxygen and water in the presence of a catalyst at a temperature between about 150° C. and about 400° C.

11. A process for the production of ethylene oxide which comprises subjecting ethylene to the simultaneous action of oxygen and water in the presence of a catalyst essentially containing silver.

12. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen end water at a temperature between 150° and 400° C. in the presence of a catalyst composed of silver activated by small quantities of a metal selected from a group consisting of gold, copper and iron.

13. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of the oxygen and water at a temperature between 150° and 400° C. in the presence of a catalyst composed of a mixture of silver, gold, copper and iron.

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3 ~~14.~~ A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water at a temperature between 150° C. and 400°C in the presence of a catalyst composed of a mixture of silver and gold.

4 ~~15.~~ A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen and steam at a temperature between 150° and 400° C., and at a pressure below atmospheric pressure, in the presence of a catalyst composed of a metal selected from a group consisting of silver, gold, copper and iron, and in the presence of hydrogen in the proportion of 5 per cent of the total volume.

5 ~~16.~~ A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen and steam at a pressure below atmospheric pressure, in the presence of a catalyst composed of a metal selected from a group consisting of silver, gold, copper and iron, and in the presence of hydrogen in the proportion of 5 per cent of the total volume, and of CO_2.

6 17. A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen, steam and hydrogen at a temperature between 150° and 400° C. in the presence of a catalyst composed of silver activated with small quantities of gold.

7 18. A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen, steam and hydrogen at a temperature between 150° and 400° C. in the presence of a catalyst composed of silver activated with small quantities of a mixture of gold and copper

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IN TESTIMONY WHEREOF I AFFIX MY SIGNATURE. Theodore Emile Lefort

OATH

Republic of France :

Department of Seine : SS.

City of Paris :

REPUBLIC OF FRANCE, CITY OF PARIS } ss
CONSULATE GENERAL OF THE UNITED STATES OF AMERICA }

THEODORE EMILE LEFORT, the above-named petitioner, being duly sworn, deposes and says that he does verily believe himself to be the original, first and sole inventor of the improvement set forth and claimed in the foregoing specification and for which improvement he solicits a patent; that he does not know and does not believe that said improvement was ever before known or used; that he is a citizen of the Republic of France and resides at Paris in the Department of Seine; that he verily believes that the Letters Patent referred to in the foregoing Petition and Specification, and the surrender of which is hereby tendered, are in part inoperative and/or invalid for the reasons that the specification may be in part uncertain in describing the invention, and that there may be claimed therein as his invention and discovery more than he had a right to claim as new, and that there is failed to be claimed therein more specifically subject-matter of his invention which he had a right to claim as new, and that such defects consist particularly in the statements relative to the invention occurring at page 1, first two paragraphs, and in the claims, which fail to point out the particular scope of applicant's invention wherein ethylene is catalytically oxidized to ethylene oxide, and particularly by means of molecular oxygen.

Deponent further says that the errors which render such patent so inoperative and/or invalid arose from inadvertence, accident or mistake and without any fraudulent or deceptive intention on the part of deponent, and that the following is a true specification of the errors which it is claimed constitute such inadvertence, accident or mistake, to wit;

(a) The specification and claims do not emphasize sufficiently clearly that the process of oxidizing ethylene to ethylene oxide is operable whether or not water is present, and that the presence of water in the reaction is but one preferred embodiment of the invention; that this is the intent and contemplation is shown by the equation at lines 11 to 15, page 1, 1st column; at lines 34 to 44, page 1, 2nd column, concerning the probable effect of the added water; at lines 1 to 5, page 2, 2nd column, where it is stated that "***water, in the form of steam or not, considerably promotes the reaction***"; by lines 17 to 19, page 2, 1st column, where it is stated that means merely "allowing" the introduction of water are provided; and as will more fully appear by reference to the description of the process contained in the applications filed in France by deponent and referred to in the oath accompanying the original application.

(b) The specification and claims do not emphasize sufficiently clearly that silver, alone or activated, is the preferred catalytic agent for conducting the process of the invention; that this is the intent and contemplation is shown by reference to the second and third examples of the process at lines 28 to 30 and line 41, page 2, 1st column, and at lines 22 to 27, page 1, 2nd column.

(c) The claims are phrased in uncertain language and the grammatical construction thereof does not permit accurate definition of the invention, and there are failed to be claimed specific features of the invention which deponent had a right to claim as new, and which are claimed in claims 1 to 11, inclusive.

Deponent further says that such errors so particularly specified arose or occurred as follows: through failure of the applicant and his attorney to appreciate fully the relation of the claims to the preferred scope of the invention, and failure of applicant to instruct adequately his attorney in the fullest benefits and application of his invention, namely, in the production of ethylene oxide by oxidation of ethylene in the presence of catalysts with or without the inclusion of water in the reaction. This failure to appreciate fully these features of applicant's process arose, at least in part, through the fact that applicant is a resident of France and is not familiar with the law, rules and procedures relative to the application for and grant of United States Letters Patent coupled with the fact that applicant's attorney had no knowledge of or information relative to the invention other than that contained in the corresponding applications for patent filed in France. Recently the present assignee of the said Letters Patent, through its technical representatives and patent counsel, carefully studied applicant's process and the said Letters Patent, and observed and ascertained the defects and errors specified above, and the fact that the claims are uncertain and/or of breadth incommensurate with the invention. Promptly upon the discovery of the failure of the patent to include a clear statement of the invention as appears at lines 1 to 25 of page 2 of the present application, and to include claims in the form of those numbered 1 to 11, inclusive, of

the present application, this application for the reissue of the said Letters Patent No. 1,998,878 was prepared, and is submitted herewith.

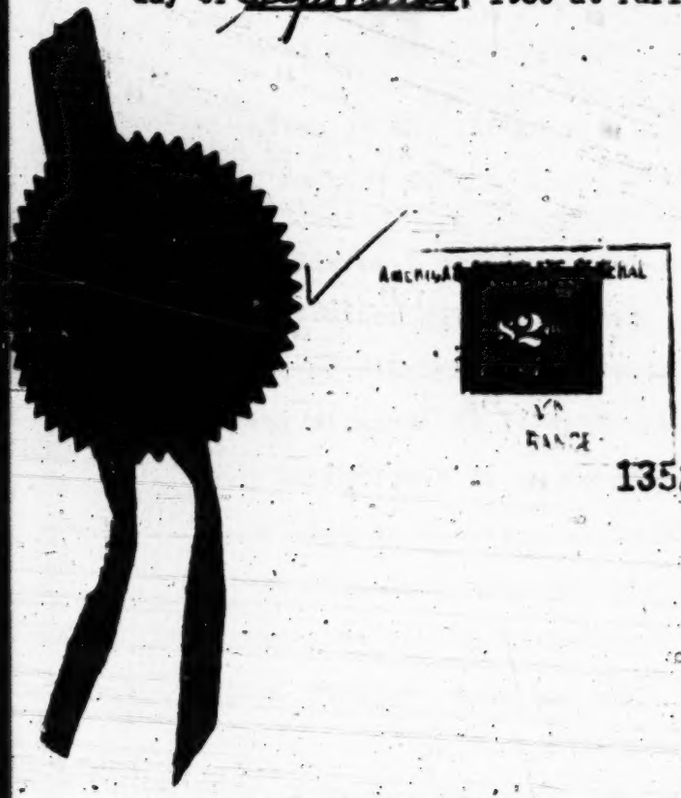
Theodore Emile Lefort

Sworn to and subscribed before me this tenth day of September, 1936 at Paris, France.

Paul C. Betts

United States Consul.

PAUL C. BETTS
Vice Consul of the United States of America at Paris, France



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Defendant's Exhibit 4 (Continued)

Div. 39 | Room 4709 ENG:EH

DEPARTMENT OF COMMERCE
UNITED STATES PATENT OFFICE
WASHINGTON

Paper No. 2

Please find below a communication from the EXAMINER in charge of this application.

Commissioner of Patents.

Applicant: T. E. Lefort

Ser. No. 102,613
Filed Sept. 25, 1936
For Process for the Production of Ethylene Oxide.

Charles C. Scheffler,
30 E. 42nd St.,
New York, N. Y.

MAILED
OCT 21 1936

This application has been examined and the following references are made of record:

Walker 972,953 Oct. 18, 1910 260/54
Willstatter et al, Liebig's Annalen der Chemie Vol. 422 (1920) pp. 36 to 46.
Lenher, Journal of the American Chemical Society, Vol. 54, 1932, pp. 1830-1837.

Claims 1 to 11 are rejected as without patentable merit over Willstatter cited herewith, who discloses inter alia the oxidation of ethylene in the presence of a variety of catalysts including silver. It is said that ethylene oxide may be attained by such oxidation. It is noted that in presenting the original case and also in distinguishing over this reference in the original applicant finally restricted the claims to specified catalyst and indicated that such catalysts and the presence of steam enabled increased yields. In other words, the case was presented as an improvement over prior known processes of oxidation of ethylene, so as to increase the yield of ethylene oxide. It appears to be too late to now urge that applicant is the pioneer inventor of processes of oxidizing ethylene.

It is noted that claims 9 and 10 now presented are virtually the same as claims 1 and 5 of the original, which were withdrawn after the citation of art. Claims 1 to 8 and 11 are of still broader scope and would accordingly be subject to the same rejection. A reissue proceeding is a proceeding only to correct inadvertent errors and not to recapture a broad field that was abandoned or dedicated after the citation of art.

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S.N. 102,613

- 2 -

Claims 1 to 11 are accordingly further rejected as not proper subject matter for reissue.

Claims 12 to 18 may be allowed as at present advised.

The original must be surrendered before allowance.

PM Shepard

Examiner.

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description or disclosure of anything related to the Lefort process. The official letter, speaking of Willstätter, states: "It is said that ethylene oxide may be attained by such oxidation." It is not clear where this is said. Certainly it was never said by Willstätter nor by anyone acquainted with his work. Because of the preeminent position occupied by Willstätter in the field of organic chemistry, it is unquestionably true that his work reported in the Annalen was a greater deterrent to attempts to oxidize ethylene than was anything else in this art. Surely the fact that Willstätter was so completely lacking in success in the catalytic oxidation of ethylene to useful products is proof to all conversant with his work that this field would not be fruitful.

One of the affidavits submitted herewith is concerned specifically with the chemical history and chemical action involved in the oxidation of olefines, in particular ethylene. This affidavit shows the vast chemical distinctions between various types of oxidation carried out by prior workers including Willstätter, and the unique chemical action of the present invention by which Lefort succeeded in adding directly a single atom of molecular oxygen to the ethylene molecule. Dr. George O. Curme, Jr. occupies a position in aliphatic chemistry almost without parallel. He is regarded as the founder of a truly American chemical industry in the synthesis of aliphatic compounds from ethylene and its homologues, and is acknowledged to be one of the world's foremost organic chemists. He has wide acquaintance and personal experience with the subject matter of the Willstätter article and with the production of ethylene oxide. He, like Willstätter and following Willstätter, carried out researches on the oxidation of

U. S. PATENT OFFICE
APR 12 1937
DIVISION 59

IN THE UNITED STATES PATENT OFFICE

Div. 59, Room 4709 : Serial No. 102,613

T. E. Lefort : Filed Sept. 25, 1936

PROCESSES FOR THE PRODUCTION OF ETHYLENE OXIDE

Hon. Commissioner of Patents

Washington, D. C.

Sir:

In response to the Official Action of Oct. 21, 1936, there are submitted herewith an amendment, together with a supplemental oath by the inventor, and three affidavits, which will be presently discussed. As is pointed out in the remarks accompanying the amendment, the description of the invention has been revised extensively (in words, not in substance) to place it in better form, and this has been accomplished by providing a clean copy of the amended description to avoid confusion which probably would otherwise result. This action was approved by the Examiner at a conference March 13, 1937.

Earlier submission of the amendments and accompanying affidavits has been impossible since those signed in France travelled via the Queen Mary, which arrived April 5, 1937.

Claims 1 to 11 were rejected "as without patentable merit over Willstätter", whose article with Max Bommer on oxidation of ethylene with molecular oxygen appears at pages 36 to 46, Volume 422, Annalen der Chemie. This rejection will not apply to claims 19 and 20 which now replace the claims 1 to 11 cancelled without prejudice. Willstätter provides no

ethylene with molecular oxygen of the air, and learned nothing in any way suggestive of the formation of the product which Lefort now has shown how to make. It is believed that consideration of Dr. Curme's affidavit and the facts contained therein will so clearly remove the last vestige of doubt as to the relation of the Lefort process to such art as the Annalen article by Willstätter and Bommer as to render further comment superfluous.

The Examiner has noted in the Official letter that in presenting the original case and in distinguishing over the Willstätter article which was cited against the original claims, the claims were restricted to a specified catalyst indicated to be useful to increase yields of ethylene oxide. This occurrence was due to the double mistake of applicant's solicitor in the original application and of the Patent Office. The events leading to the misapprehension of the real nature of this invention by applicant's original solicitor will clearly appear from the facts stated in the supplemental oath of the inventor and the affidavits by his French attorney, M. Guichard, and the attorney in charge of the application in this country, Mr. Jakobsson. This unfortunate chain of circumstance, in which the inadvertence of the French solicitor and the inventor combined with the mistaken application by the Patent Office of art which in fact was inappropriate and inapplicable to the claims, clearly creates such a situation as the reissue statutes are designed to correct. The Supreme Court in its decision in Topliff v. Topliff, 145 U. S. 156, at page 171, succinctly summarized what should be done in such cases. The case of In re Heroult, 1907 C. D. 521 (App. D. C.) likewise discusses a remarkably similar situation in which a French inventor was inadvertently deprived of protection for

his real invention and was permitted to remedy that mistake by reissue. The remedy sought in this case is no more than equity demands and precedent sanctions.

The Examiner has pointed out that the original application was presented as an improvement over prior known processes of oxidising ethylene. Applicant is perfectly willing to have the invention regarded as an improvement on previous processes of oxidizing ethylene by means of molecular oxygen, so long as it is clearly understood that the "improvement" provided by him is that of for the first time making possible the addition of a single atom of oxygen from molecular oxygen to the ethylene molecule to give for the first time ethylene oxide as a direct product of this oxidation. It is not too late to acknowledge the fact that applicant has made a basic invention and has pioneered an entirely new type reaction in organic chemistry which has the outstanding distinctions of being both chemically unique and industrially valuable.

Certain of claims 1 to 11 were rejected as being of substantially the same, or of broader, scope than claims which were cancelled from the original application after the citation of art. Specifically, the Examiner referred to the cancellation of claims 1 to 5, which were rejected in the original application by the Official letter dated June 24, 1933 on reference to the Willstätter article, supra, in view of an article by Lenher, J.A.C.S. 53, pages 2420 to 2421; 1931. Following this rejection, claims 1 and 5 were cancelled by an amendment filed December 22, 1933. It is clear that both the rejection of those claims in the original application and their cancellation were due to the inadvertent mutual mistake on the part of the

Patent Office and applicant's then solicitor. The Patent Office erred in applying the article by Lenher to the rejection of claims both by reason of its lack of relevancy to the process claimed by Lefort and because its publication date, namely June 8, 1931, was subsequent to the date of March 27, 1931, available to the applicant under the provisions of the International Convention. In similar fashion, applicant's solicitor inadvertently failed to point out these two facts to the Examiner and mistakenly acquiesced in the position of the Office. Since the withdrawal of the claims 1 and 5 from the original application was due to a mistake of fact and not to an error in judgment on the part of applicant or his solicitor which could have been remedied by appeal, it is clear that there is no estoppel against the present claims which can arise from this action. Moreover, claims 19 and 20, which have replaced claims 1 to 11, are not open to this ground of rejection even if it were in fact valid,- which it is not. The claims 19 and 20 which are now sought to protect applicant's invention have been carefully drafted to include all of the essential features of the Lefort process, and have been restricted in number for the convenience of the Office and to simplify prosecution of this application. These claims much more accurately define the invention than those which they supplant, and applicant is willing to rely on them for the protection of his invention, and chooses not to press further for other claims to his invention. Because these claims include as elements of the process certain features which were not heretofore contained in any claims drafted to this invention, it is plain that they do not represent any attempt to retrieve anything which could have been abandoned or lost to the public. The allowance of these

47. claims is believed to be clearly in order, and the facts

justifying this will be apparent from the oath of the inventor and the affidavits which have been submitted. There is no existing reason for not permitting applicant to secure protection for his invention in scope defined by claims 19 and 20, and this is especially the case where, as here, the invention is basic. Authority for all of the foregoing contentions will appear from the digest contained in Section 274, pages 354 and 355, "Walker on Patents", 6th Edition, Volume I.

Consideration of statements in the oath of the inventor annexed to the amendments to the description and claims, together with the accompanying affidavits of Dr. Curme, M. Guichard and Mr. Jakobsson, is urged. It is asked that the application be passed to issue in its present form, and the original patent will be surrendered as soon as such action is indicated.

Respectfully submitted,

Eugene A. Greenwald
Attorney for Applicant

New York, N. Y.
April 7, 1937

F/D

U. S. PATENT OFFICE
APR 19 1937
DIVISION

APR 10 1937
PATENT OFFICE

IN THE UNITED STATES PATENT OFFICE

Div. 59, Room 4709 : Serial No. 102,613

Theodore E. Lefort : Filed September 25, 1936

PROCESS FOR PRODUCING ETHYLENE OXIDE

Hon. Commissioner of Patents

Washington, D. C.

Sir:

In response to the Official letter of October 21, 1936, please amend the above application as follows:

Cancel pages 2 to 6, inclusive, of the specification, and rewrite as follows:

This invention provides a specific and novel process for making ethylene oxide. It essentially consists in causing ethylene to combine directly with molecular oxygen at temperatures of about 150° to about 400° C. in the presence of a surface catalyst which favors the oxidation of ethylene to ethylene oxide under these conditions. The process can be carried out at atmospheric pressure, and it may also be conducted at pressures above or below atmospheric pressure.

This process is characterized by an entirely unique reaction in which the direct addition of a single oxygen atom to the ethylene molecule occurs without the formation of significant amounts of other oxygenated compounds such as aldehydes. This novel reaction may be expressed as:

$2\ CH_2{=}CH_2 + O_2 \longrightarrow 2\ CH_2\text{-}CH_2$ (with O) and it is accompanied by complete oxidation of some of the ethylene to give carbon dioxide and water according to the equation:

$CH_2{=}CH_2 + 3\ O_2 \longrightarrow 2\ CO_2 + 2\ H_2O$

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Ethylene from any desired source may be used, including that obtained from coke oven gas, hydrogenation of acetylene, or dehydration of ethyl alcohol. The oxygen can be the oxygen of the air, and can conveniently be mixed with the ethylene prior to the reaction.

The oxidation of ethylene takes place with a giving off of heat, and it is, of course, desirable to maintain the temperature of the zone of reaction within the range specified. This can be facilitated by suitable dilution of the reaction gases, such as that accomplished by the use of air as the source of oxygen, and some water or carbon dioxide in addition to that formed can be admitted to the mixture in the reaction zone if desired. Hydrogen may be similarly added.

The process can be conveniently conducted by passing a mixture containing air and ethylene through a tube, for example, of silica or of a material capable of withstanding high pressures, within which is placed such a surface catalyst as one composed of silver in finely divided form, and which may be disposed within the tube on a supporting material, or in other known ways. The temperature of the reaction zone is maintained between about 150° and about 400° C., for example, at about 200° C., and the issuing products from the tube contain ethylene oxide, carbon dioxide and water without objectionable aldehydes. The ethylene oxide can be recovered in any suitable way, preferably in liquid form by condensation or solution.

The surface catalyst is preferably silver as stated, but other metals such as bismuth and antimony may be used. Likewise oxides of these metals or mixtures containing these metals or their oxides may be used. Experiments have also indicated that the catalyst may be silver activated by the addition of small amounts of gold or copper or iron.

In any case, the ethylene and oxygen are thus reacted simultaneously at the temperatures set forth in the presence of a surface catalyst and of water, and the process is conducted to produce ethylene oxide as a direct product in substantial and economic amount. The ethylene oxide can be recovered by known methods, and it may be further reacted to form ethylene glycol or derivatives of ethylene glycol.

Cancel claims 1 to 11, inclusive, without prejudice, and substitute the following:

-- ~~12.~~ The process of making ethylene oxide by the direct chemical combination of oxygen with ethylene in the proportions of one atom of oxygen to one molecule of ethylene, which comprises forming a mixture containing ethylene and molecular oxygen and conducting said mixture through a confined reaction zone which is maintained at an elevated temperature; controlling said temperature to maintain said mixture in said zone at a temperature between about 150° and about 400° C.; subjecting said mixture in said zone at said elevated controlled temperature to intimate contact with an active surface catalyst of a material having the catalytic characteristics of silver which favors the direct oxidation of said ethylene in said mixture by said molecular oxygen to form oxidation products containing ethylene oxide in the presence of water and which does not favor the existence in said products of substantial amounts of aldehydes; correlating the passage of said mixture through said reaction zone in the presence of said catalyst and the controlled elevated temperature of said mixture and said catalyst to effect

said oxidation of said ethylene directly to form substantial amounts of ethylene oxide; and thereafter recovering ethylene oxide-containing product in liquid form.

20. The process of making ethylene oxide by the direct chemical combination of oxygen with ethylene in the proportions of one atom of oxygen to one molecule of ethylene, which comprises forming a mixture containing ethylene and molecular oxygen and a heat-absorbing diluent and conducting said mixture through a confined reaction zone which is maintained at an elevated temperature; controlling said temperature to maintain said mixture in said zone at a temperature between about 150° and about 400° C.; subjecting said mixture at said elevated controlled temperature to intimate contact with an active surface catalyst material composed essentially of silver which favors the direct oxidation of said ethylene in said mixture by said molecular oxygen to form oxidation products containing ethylene oxide in the presence of water and which does not favor the existence in said products of substantial amounts of aldehydes; correlating the passage of said mixture through said reaction zone in the presence of said catalyst and the controlled elevated temperature of said mixture and said catalyst to effect said oxidation of said ethylene directly to form substantial amounts of ethylene oxide; and thereafter separating ethylene oxide from the products of oxidation.

REMARKS

In order to place this application in better form, applicant deems it essentially desirable to make numerous revisions in the description of his invention. Because these

revisions would result in extensive amendments to the specification now on file and lead to possible confusion, a completely rewritten description of the invention has been provided in clean copy. The rewritten description principally provides a representation of the disclosure of the invention from which portions of the original description have been deleted and the whole rephrased in clearer language. This matter was discussed at a conference with the Examiner on March 13, 1937, at which time informal approval of the above amendments containing the rewritten description was received.

The supplemental oath and the affidavits attached will make apparent the reasons for the several amendments, and will clearly show that claims 19 and 20, which replace the claims 1 to 11, hereby cancelled without prejudice, are allowable. Claims 12 to 18 have previously been allowed, and allowance of claims 19 and 20 is respectfully asked.

Respectfully submitted,

Eugene L. Greenwald
Attorney for Applicant

New York, N. Y.
April 7, 1937

F/D

SUPPLEMENTAL OATH

REPUBLIC OF FRANCE :
:
CITY OF PARIS :
: ss.:
CONSULATE GENERAL OF THE :
UNITED STATES OF AMERICA :

THEODORE EMILE LEFORT, whose application Serial No. 102,613, for Reissue of Letters Patent No. 1,998,878, was filed September 25, 1936, being first duly sworn, deposes and says that he does verily believe himself to be the original, first and sole inventor of the improvements in PROCESSES FOR THE PRODUCTION OF ETHYLENE OXIDE set forth and claimed in said application Serial No. 102,613 and forming the subject matter of the annexed amendment to said application and for which improvements he solicits a patent; that he does not know and does not believe that said improvements were ever known or used before his invention or discovery thereof, or patented or described in any country before his invention or discovery thereof or more than two years prior to his original application Serial No. 600,578 for a patent therefor, or in public use or on sale in the United States more than two years prior to his said original application for a patent therefor; that said invention has not been patented in any country foreign to the United States on an application filed by him or his legal representatives more than twelve months prior to his original application Serial No. 600,578; and that no application for patent on said improvement was filed by him, or his representatives or assigns in any country foreign to the United States, before the filing of his said application Serial No. 600,578, except as stated in his Oath

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accompanying his said original application; that he is a citizen of the Republic of France and resides in the City of Paris; that he verily believes that the Letters Patent No. 1,998,878 referred to in the Petition and Specification of said application Serial No. 102,613, and the surrender of which has been thereby tendered, are in fact inoperative and/or invalid for the reasons set forth in the oath annexed to and forming part of said application Serial No. 102,613, and for the reason that the specification is defective and insufficient and that such defects and insufficiencies consist particularly in the failure to adequately claim the real invention, in the failure to point out and explain the particular scope of deponent's invention which consists essentially in the oxidation of ethylene by means of molecular oxygen in the presence of silver or other suitable catalyst which acts in the process like silver to form ethylene oxide in substantial amount and without substantial amounts of aldehydes and then utilizing the ethylene oxide product, and in the innocent mis-description in the specification of several substances as satisfactory catalysts; and deponent further says that the errors which render such patent so inoperative or invalid arose from inadvertence, accident and mistake, and without any fraudulent or deceptive intention on the part of deponent; that the following is a further true specification of the errors which it is claimed constitute such inadvertence relied upon; the failure to present claims more commensurate with the real invention, the absence of claims in said patent which are operative to secure

to deponent his real invention, the failure more clearly to explain the particular scope of the real invention, the failure more clearly to point out that a substantial quantity of water is inherently present in the reaction tube due to the substantial independent oxidation of ethylene to carbon dioxide and water, the failure to make clearer that the addition of water or carbon dioxide or both to augment the water and carbon dioxide inherently and independently formed, as well as the addition of hydrogen, are merely supplemental features still within the scope of the real invention, and the description of certain substances as alternative catalysts which deponent now disclaims namely, lead, nickel, tin, arsenic, gold, copper and iron per se, and further in the failure of the specification to contain a description of the invention in the words and language provided by the annexed amendment to the specification of said application Serial No. 102,613, and in the failure to claim as deponent's invention or discovery that which he had a right to claim as new, and which is claimed in claims 19 and 20 of the annexed amendment to application Serial No. 102,613; and that such errors so particularly specified arose as follows:

Deponent is totally unfamiliar with the laws and rules governing the issuance and construction of Letters Patent of the United States. Until shortly before the application for reissue of the said patent, deponent was ignorant of the existence of any difference between French patent law and that of the United States. Not being advised of such difference during the prosecution of the application

resulting in the issuance of said Letters Patent or until shortly before the application for reissue thereof, deponent believed that the United States patent law was the same as that of France. Accordingly, deponent believed that, being the first to disclose the invention which is the subject of said Letters Patent, he thereby would and did secure, by the issuance of said Letters Patent, whatever might be new as therein described irrespective of the language of the claims. Deponent further believed that, as he was the first to disclose a process of oxidizing ethylene by the oxygen of the air and the aid of a catalyst into ethylene oxide, he obtained the fullest protection of his invention by the issuance of Letters Patent which merely set forth all specific features which he contemplated as original with him.

Deponent says that on March 27, 1931, when he applied for his first French patent on the said invention, and at all times thereafter, he verily believed that he was the first to discover and disclose that molecular oxygen could be made to react with ethylene in the presence of a surface catalyst to form ethylene oxide without aldehydes in substantial amounts.

Deponent further states that he failed to present adequate claims to his real invention because he believed that the protection afforded by the patent was delineated by the disclosure as in French law, and that the claims were, as in the case of the resumé in a French patent, a mere formal appendage of no controlling importance. A resumé in a French patent is in the nature of a formality and does not control the protection afforded by the disclosure of the

patent. Throughout the entire prosecution of the application deponent, due to these mistaken beliefs, centered his attention upon retaining a description of the invention in its narrower aspects of possible specific variations, relying on the range of disclosure rather than on the claims to afford scope of protection to which he believed, and still believes, himself entitled.

Deponent through inadvertence failed to stress to his attorney the point that a substantial quantity of water was inherently present by reason of independent complete oxidation of some of the ethylene giving water and carbon dioxide, and that any augmentation of this water by the direct addition of water to the reaction zone might be practiced or omitted as desired.

Deponent further states that at no time did he explain to his attorney, L. Guichard, the scope of the said invention with respect to the prior art, and that M. Guichard was the attorney of the firm of Elluin and Barnay who was solely responsible for all patent applications with respect todeponent's invention.

Deponent further says that he verily believes that his said attorney, through inadvertence and mistake, believed that the oxidation of ethylene to ethylene oxide comprised the formation of formaldehyde as an intermediate product. Deponent believes that his attorney, through inadvertence and mistake, believed that references disclosing methods for obtaining formaldehyde by the oxidation of ethylene anticipated the broad aspect of deponent's invention.

Deponent further says that these erroneous beliefs of his attorney arose by reason of deponent's inadvertence and mistake in failing to communicate his invention to his attorney by pointing out what was excluded from it as well as what was included in it. It was only after the issue of deponent's patent No. 1,998,878 that deponent discovered the defects thereof now sought to be corrected and discovered the matters of inadvertence, accident and mistake which combined to occasion them.

Deponent further says that he neglected adequately to impress his attorney to note that the date of the publication of an article by Lenher in Journal of the American Chemical Society, Volume 53, pages 2420-2421, namely, June 8, 1931, was later than the priority date of March 27, 1931 on which deponent relied, and to which deponent was entitled by virtue of the International Convention.

Deponent further says that the catalyst first used in practicing his invention was a commercial grade of antimony containing a substantial quantity of arsenic as an impurity therein. This mixture was an effective catalyst. Later a spectrographic analysis of this mixture was made and it was found that it was composed of the substances set forth at page 1, column 1, lines 23-5 of the patent. From this it was concluded first that none of these substances acted as negative catalysts. Later runs were made with chemically pure antimony and the results were inferior to those obtained with commercial antimony. From this it was concluded that these impurities were themselves catalysts. Then, before all these substances which were present in the

commercial antimony as impurities could be studied as to their individual catalytic effects, deponent found that silver was the most excellent catalyst for the reaction. After that time deponent directed efforts solely toward exploring the possibilities of the use of silver as a catalyst. In his application for United States patent, deponent endeavored to disclose as fully as possible the results of his work and permissible deductions therefrom. Therefore deponent included in his description all substances which he had reason to believe were suitable catalysts but endeavored at the same time to make clear that silver, antimony and bismuth were the principal catalysts with which he was concerned (patent p. 1, column 1, 11, 26, 27, 28, 31-2, 48-9, 51; p. 2, column 1, 11, 28-49).

Lest deponent's beliefs as to lead, nickel, tin, arsenic, gold, copper and iron per se be questioned on the ground that they were premised on insufficient evidence, deponent is willing to exclude mention of such metals from his specification and confine his disclosure to those metals used in successful tests.

Chevalier Emile Lefort

Sworn to before me this 30th day of March 1937, at Paris, France.

United States Consul
JOHN R. WOOD
Vice-Consul of the United States
of America at Paris, France

3082

DIVISION
APR 10 1937
U. S. PATENT OFFICE
U. S. PATENT OFFICE
APR 19 1937
DIVISION 59

IN THE UNITED STATES PATENT OFFICE

Div. 59, Room 4709 : Serial No. 102,613

Theodore E. Lefort : Filed Sept. 25, 1936

PROCESS FOR PRODUCING ETHYLENE OXIDE

A F F I D A V I T

State of New York :
: ss.
County of New York :

GEORGE O. CURME, JR., vice-president of Carbide and Carbon Chemicals Corporation, New York, New York, a citizen of the United States and a resident of White Plains, New York, being duly sworn, deposes and says:

1. QUALIFICATIONS

I am a chemist with the degrees of Bachelor of Science and of Doctor of Science (honorary) from Northwestern University and the degree of Doctor of Philosophy from the University of Chicago, and my graduate studies in chemistry additionally include study at Harvard University, at the Kaiser Wilhelm Institute and at the University of Berlin in Germany.

In 1933 the Chandler medal was presented to me by the Charles Frederick Chandler Foundation for research in synthetic aliphatic organic chemistry and for the advancement of industry through its commercial applications; in 1935 I received the Perkin medal, awarded by the American Section of the Society of Chemical Industry for advancement of applied

chemistry through developments with which I have been associated in bringing into commercial production new products derived from ethylene and propylene and including ethylene oxide, ethylene glycol, ethylene dichloride, ethylene chlorhydrin, ethyl alcohol, isopropanol and acetone; and in 1936 I received the Elliot Cresson medal, awarded by the Franklin Institute, Philadelphia, for research which resulted in the development of industry based on synthetic aliphatic compounds, derived from the olefines.

For the past twenty-three years I have been engaged in and intimately associated with research in aliphatic chemistry, and in the industrial development of synthetic aliphatic chemistry, and I have for the past seventeen years been respectively Chief Chemist, Director of Research and Vice-President of Carbide and Carbon Chemicals Corporation, which organization has been active in technical research and commercial development of new chemical products and processes derived from ethylene and the homologous olefine gases, prominent among which products have been ethylene glycol and other derivatives of ethylene oxide.

As a result of my studies, activities and interests in the fields set forth, I am thoroughly familiar with the technical and patent literature concerning particularly the production of ethylene oxide and ethylene glycol or derivatives of ethylene oxide from starting materials such as ethylene.

I am familiar with patent 1,998,878 granted April 23, 1935 to T. E. Lefort, and with the application Serial No. 102,613 for reissue of patent 1,998,878, which application was

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filed September 25, 1936, and I have been intimately associated with further research and development on the process for the production of ethylene oxide by the direct, catalytic addition of a single oxygen atom to ethylene which forms the subject matter of that patent and the application for its reissue.

2. HISTORY OF DIRECT OXIDATION OF OLEFINES

To the best of my knowledge and belief, the history of the direct oxidation of olefines is as follows:

Uncatalyzed Oxidation

The study of the reactions of olefines with molecular oxygen (O_2) dates back to 1879, when Schutzenberger discovered that the controlled oxidation of ethylene with the molecular oxygen of air at about 400° C. gives recognizable amounts of formaldehyde. Bone and Wheeler studied this reaction, mostly in the absence of catalysts, and found that it is quite slow below 500° C. They obtained only traces of formaldehyde, since this product is readily further oxidized to oxides of carbon and water.

Richard Willstätter and Max Bommer (Ann. 422, 36; 1920) studied the oxidation of ethylene with the molecular oxygen of air for the practical purpose of making formaldehyde. They found that, when the ethylene is dilute, the contact time short and the temperature about 600° C., it is possible to remove the formaldehyde from the reaction zone before it has been completely oxidized. However, their highest reported yield of formaldehyde represented only 3% of the ethylene introduced and 50% of the ethylene reacted. Willstätter patented the process (Ger. pat. 350,992), but apparently it had no

commercial success. Blair and Wheeler (J.S.C.I. 41, 303T; 1922) studied the same reaction at length, and in general confirmed the conclusions of Willstätter and Bommer.

Shortly after the publication of the above article by Willstätter and Bommer, experimental work on the oxidation of ethylene with molecular oxygen of the air was carried out under my personal direction in the laboratories of Carbide and Carbon Chemicals Corporation. The results obtained in this work, which was not published, were substantially the same as those reported by Willstätter and Bommer.

Higher olefines were found, like ethylene, to give aldehydes on oxidation with molecular oxygen. Engler (Ber. 33, 1094; 1900) and Lewis (J.C.S. 1929, 759) showed that in the low temperature oxidation of amylene with the molecular oxygen of air, peroxides are formed to a certain extent as intermediates. In general, peroxides are formed as the primary products of the oxidation of olefinic substances with molecular oxygen, as shown by the following equation:

$$H_2C = CH_2 + O_2 \longrightarrow H_2C\!-\!CH_2 \quad \text{(O–O)} \qquad \text{I.}$$

These are highly unstable substances which usually break down wholly or in part under the conditions of their formation to secondary products, such as aldehydes, olefine oxides, organic acids and oxides of carbon.

I believe the first intimation in the chemical literature that ethylene oxide can be made by the uncatalyzed oxidation of ethylene with molecular oxygen was published as a short "Communication to the Editor" by Lenher (J.A.C.S. 53, 2420; June 8, 1931). According to Lenher, the oxidation of

ethylene with the molecular oxygen of air seems to take place in two ways; one being the direct oxidation of ethylene to formaldehyde, and the other being the formation of a peroxide which in turn yields ethylene oxide, dioxymethyl peroxide, hydrogen peroxide, formaldehyde and other products. Since organic peroxides in general are highly unstable at elevated temperatures, it is not surprising that Lenher obtained a multiplicity of products, resulting from the decomposition of the primary peroxide, and only small yields of any one product. In order to produce ethylene oxide, Lenher used lower reaction temperatures than those of Willstätter and circulated the gases through the reaction zone and through an apparatus for absorbing the condensable reaction products. Only traces of ethylene oxide were formed in each passage through the reaction zone, but the eventual effect of an uncounted number of passes was to accumulate appreciable amounts of ethylene oxide in the absorber. The amount of ethylene consumed per pass was also small, but sufficient that at best the ethylene oxide obtained was equivalent to some 20% of the ethylene consumed. The low ultimate yield would indicate that commercial success of the process is unlikely, and the fact that only traces are produced per pass seems to exclude the process as described entirely from commercial consideration. A patent on the process (U. S. 1,995,991) was assigned to E. I. du Pont de Nemours & Company, but apparently no attempt has been made to operate it on a substantial scale.

Beside the low amount of reaction per pass, a distinguishing characteristic of Lenher's procedure was that wide, empty tubes or other reaction vessels were employed, whereas

Willstätter used tubes having a diameter of only 3 mm. Lenher found that the reaction giving ethylene oxide was prevented or hindered by the catalytic action of any surface such as those of narrow or packed tubes. He concluded that the reaction is a chain reaction occurring in the gas phase, and that the chains are shortened or prevented by surfaces in general. Such chain reactions, that is, reactions in which the energy necessary for activation is passed on from molecule to molecule, have in recent years been found to occur in many cases of oxidation.

Catalyzed Oxidation

Early in the work on the oxidation of olefines with molecular oxygen, it was recognized that catalysts accelerate such reactions. There is no report, however, of any successful catalytic oxidation involving only the direct addition of a single oxygen atom to the ethylene molecule. Acceleration of the oxidation reaction by metals and oxides was noted by Phillips (Z. anorg. Ch. 6, 213; 1894), Bone and Smith (J.C.S. 87, 910; 1905), and Sabatier (Die Katalyse in der organischen Chemie). Willstätter and Bommer reported that oxidation catalysts in general lower the temperature at which effective oxidation of ethylene with molecular oxygen takes place. They apparently studied this sort of oxidation quite thoroughly, since they had reason at the outset to suppose that catalysts would help them. The lower reaction temperature would be expected to be favorable, especially because some of the oxidation catalysts were known to be effective in producing formaldehyde by the oxidation of methanol. However, the results from their catalytic work were apparently unproductive, and the

work was not referred to in their patent, but mentioned briefly in their article in the Annalen (supra). The catalysts tried by these authors to promote the oxidation of ethylene with molecular oxygen did not yield formaldehyde or any other valuable product, so far as can be learned from their writings.

On the other hand, Wheeler and Blair found that under certain conditions the catalytic oxidation of ethylene with molecular oxygen yields some formaldehyde. Various processes have been proposed for making aldehydes and acids from olefines by the use of various oxidation catalysts. Quite generally, however, these processes involve substantial changes in the olefine molecule, usually splitting it into two parts at the double bond, as for example ethylene is believed to split when it is oxidized to formaldehyde. Lenher's work, referred to above, seemed quite convincing that the catalysts which he used are detrimental to the formation of oxidation products of ethylene retaining the original carbon to carbon linkage just as had been found by Willstätter. The following statement was made in a textbook by L. F. Hareck, Acting Director of the Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology, and D. A. Hahn, Professor of Organic Chemistry, Mount Holyoke College (The Catalytic Oxidation of Organic Compounds in the Vapor Phase, 1932, p. 212): "The direct applicability of catalysts to such an oxidation reaction (oxidation of ethylene to its oxide) for the purpose of increasing rate of reaction or increasing conversion to ethylene oxide is highly questionable in the light of present knowledge regarding chain reactions."

The first intimation in the literature that ethylene glycol, a substance related to ethylene oxide, can be made by

the oxidation of ethylene using iodine as a catalyst was published by Skärblom (U. S. 1,982,545). His process does not depend on surface catalysis, like the experiments mentioned above, but is a combination of a series of well-known reactions in the liquid phase, in homogeneous aqueous solution and at temperatures below the boiling point of water. In this reaction the ethylene reacts with iodine and with hypoiodous acid, forming ethylene diiodide and ethylene iodohydrin. These are hydrolyzed, giving ethylene glycol and hydriodic acid. The hydriodic acid finally reacts with free oxygen, regenerating iodine. The process has not been found commercially successful and need not be further discussed, since it is obviously very different from a surface catalysis of the oxidation of ethylene.

The direct addition of a single oxygen atom to an olefine bond by surface catalysis was discovered by T. E. Lefort (F. P. 729,952, March 27, 1931). His process is distinguished from Willstätter's formaldehyde process in that Lefort used certain catalysts, and obtained substantial yields of ethylene oxide, but no recognizable amounts of formaldehyde or other reaction products, excepting only carbon dioxide, water and a trace of acetaldehyde. On the other hand, Willstätter used the uncatalyzed oxidation to produce formaldehyde but no recognizable amounts of ethylene oxide.

Viewed from present knowledge, Lefort's process might be academically argued to have something in common with the laboratory experiments which Willstätter made, using various catalysts. Such a comparison could be made only by hindsight and only by one intentionally blind to the difference

between success and failure. Willstätter mentioned or implied in his paper with Bommer (Ann. 422, 36; 1920) that he made such experiments, but he did not describe them in this paper or in any other publication known to me. Apparently Willstätter and Bommer tried unfruitfully two of the same catalysts, copper and silver, which Lefort later found useful to give ethylene oxide. The net result of this experimentation by Willstätter and Bommer added nothing to the store of useful human knowledge regarding the direct addition of a single oxygen atom to ethylene which Lefort subsequently showed how to conduct easily and with excellent yield.

Richard Willstätter is widely recognized as one of the greatest organic chemists of the present time. He made great advances in extremely difficult researches, such as the studies of chlorophyll, carotenoids, and enzymes. Among many other honors, he received the Nobel Prize for chemistry in 1915, and the Willard Gibbs Medal at Chicago in 1933. It might seem obvious that a chemist of Willstätter's caliber would recognize the possibility of forming ethylene oxide and the importance of testing for it. If so, he evidently did not find any. In his article in the Annalen (supra) he described his experiments without catalysts, merely mentioning those with catalysts without a description, and in the corresponding patent (Ger. 350,922) he does not even mention specifically his catalytic experiments, but classes them along with those of others, as resultless.

Comparison of Catalyzed and Uncatalyzed Oxidation

Lefort's process is easily distinguished from Lenher's in that Lefort's depends on the surface action of certain catalysts, whereas Lenher's is inhibited or entirely prevented

by the action of surfaces. Chemically Lefort's reaction is unique, since it adds directly <u>one atom</u> of oxygen from molecular oxygen (O_2) to the olefine linkage, forming ethylene oxide, in accordance with the following equation:

$$H_2C = CH_2 + O \longrightarrow H_2C\underset{O}{\diagdown\!\!\diagup}CH_2 \qquad \text{II.}$$

In a wholly different manner, Lenher's reaction adds both atoms of a single oxygen molecule to the olefine linkage of ethylene, forming ethylene peroxide, which then breaks down giving various products (see Reaction I.). The formation of peroxides from olefine bonds by the direct addition of two atoms (i.e. a molecule) of oxygen has long been known, but Lefort's reaction, starting with free molecular oxygen and adding one atom only to the double bond, is chemically novel. It seems likely that Lefort's reaction is applicable quite generally to other olefines as well as to ethylene. In fact, its applicability to propylene has already been reported. However, the field opened by this discovery is so new that many years of study may be required before its real scope can be ascertained.

From the point of view of practical interest, Lefort's process is distinguished from Lenher's in that the yields are greatly superior. Not only does Lefort's primary reaction tend to go several times higher in the direction of ethylene oxide than that reported by Lenher for his reaction, but the conditions of operation of Lefort's reaction are such that ethylene oxide is relatively stable, as compared with the conditions of low stability reported by Lenher for his reaction. For this reason, in Lefort's process it is not necessary to limit the yields to traces of ethylene oxide per pass

through the reaction zone, but as much as 45% of the ethylene can be usefully converted to ethylene oxide in a single pass. This difference alone is sufficient to distinguish between commercial practicability and impossibility, because of the enormous amount of gases which would have to be handled in putting the process described by Lenher on a commercial scale.

In contrast to Lenher's process, which always makes more formaldehyde than ethylene oxide, Lefort's process may give total aldehydic impurities amounting to not more than 0.2% of the ethylene oxide produced. This aldehydic impurity appears to be principally acetaldehyde and contains formaldehyde in minute proportion, if at all. The acetaldehyde content of 0.2% is less than half of that contained in ethylene oxide of refined commercial grade, made by the current chlorhydrin-ethylene oxide process, now operating on a large industrial scale.

Ethylene oxide and the allied substances, ethylene glycol and its ethers, have become important commercial products in the past ten or fifteen years. The known practical processes for making these materials involve the reaction of ethylene, chlorine, and water to give ethylene chlorhydrin. About two pounds of chlorine are required per pound of ethylene oxide, and this chlorine is finally eliminated in the form of by-products. The commercial importance of a practical direct oxidation process, so far provided only by Lefort, is thus obvious.

3. TECHNICAL ASPECTS OF LEFORT'S PROCESS

During the past few months, the process disclosed in Lefort's patent and the application for reissue has been

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intensively investigated in the laboratories of Carbide and Carbon Chemicals Corporation under my direction, and I am familiar with that work and the results thereof stated below are accurate within reasonable limits of experimental error:

The catalytic oxidation of ethylene to produce ethylene oxide as a direct product proceeds satisfactorily with the use of silver or promoted silver catalysts, and catalysts of these types have been found by test to be preferable for the conduct of the process. The ethylene oxide is formed in substantial and economically valuable amounts. Tests have shown that overall yields of ethylene oxide, based on a single pass of the gases over the catalysts, as great as 45% can be consistently obtained. The efficiency of this reaction, crediting the ethylene unattacked during the first pass, is consistently above 60%, and under preferred conditions is as high as 80%. The oxidation proceeds to give results similar to those above stated at temperatures as low as 150° C. and as high as 400° C. Naturally there are certain variations in the overall yield and chemical efficiency throughout this temperature range, and the optimum temperature fluctuates within this range depending upon the related conditions of gas velocity, concentrations of ethylene and oxygen employed, and amount of active catalytic surface used. The chemical characteristics of this reaction are substantially unaffected by variations in pressure ranging upward from atmospheric to 100 psi.

Tests have shown that the proportions of ethylene and oxygen used have little, if any, effect on the chemical characteristics of the reaction. Ethylene concentrations from

1% to 80% have been tested, and oxygen concentrations from 2% to 20% have been employed. Mixtures of oxygen and nitrogen from any source may be used for reasons of economy, and preferably air is the original source of such mixtures. While the speed of reaction is somewhat reduced at low concentrations of either ethylene or oxygen, the mixtures otherwise give comparable chemical results.

It has been found that the velocity of the gases through the reaction zone does not exert a critical effect on the reaction, and the velocity need only be varied to give the degree of reaction desired, as correlated with the activity of the catalyst and the regulation of the temperature in the operation of the process.

4. CONCLUSION

From my knowledge of the Lefort process and experience with its operation, and from my knowledge of and experience with industrially used processes for the syntheses of aliphatic organic substances, I consider Lefort's invention to be one of the outstanding chemical discoveries in organic synthesis of recent years, and that it is both technically and economically suited for commercial operation and is of great industrial promise.

George O. Curme, Jr.

Sworn to and subscribed before me this 6th day of Apr 1937, at New York, N. Y.

E. Connell
Notary Public
NOTARY PUBLIC, New York County
New York County Clerk's No. 102
New York County Register's No. 8-D-139
Commission expires March 30, 1938

Filed Sept. 25, 1936

U. S. PATENT OFFICE
APR 10 1937
DIVISION

REPUBLIC OF FRANCE :
CITY OF PARIS : ss:
CONSULATE GENERAL OF THE UNITED STATES OF AMERICA :

L. GUICHARD, being duly sworn says:

I am a citizen of the Republic of France and reside in the City of Paris and I am a patent attorney associated with the firm of Elluin and Barnay. I maintain offices at 80 Rue Saint-Lazare, Paris, France. I have had no special academic or practical training in chemistry.

I acted as attorney for Société Francaise de Catalyse Generalisée in filing applications and obtaining various French patents on M. Lefort's process for obtaining ethylene oxide which is also the subject matter of United States Letters Patent No. 1,998,878, and I was solely responsible therefor.

After the various French patents had issued M. Lefort told me that he desired to protect his invention in the United States. I thereupon prepared, principally from French Patent No. 739,662, an application which I sent to Messrs. Marks & Clerk, National Press Building, 14th and F Streets, N.W., Washington, D. C., for filing in the United States Patent Office. This application, as prepared by me, was filed on March 22, 1932 and given Serial No. 600,578.

At the time that I drew the said application I had received no explanation of the nature of the invention other than in letters written to me by M. Lefort, one letter immediately preceding the filing of application for each of the various French patents. The content of each of these several letters appears substantially unchanged in the corresponding French patent. At the time I prepared the United States

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application I had no knowledge whatsoever of the state of the prior art.

From the first time when I concerned myself with patenting M. Lefort's process for the catalytic oxidation of ethylene to ethylene oxide and until after the issuance date of U. S. patent 1,998,878, I was under the mistaken belief that there was only one path by which ethylene could be oxidized, namely, through formaldehyde as an intermediate product. Apparently, M. Lefort, in turn, mistakenly believed that I knew his process accomplished direct reaction to ethylene oxide.

In June, 1932 I received a copy of German Patent No. 168,291, issued on March 15, 1906 to Dr. Johann Walter which was cited by the German Patent Office in an official action, dated June 22, 1932, on the German application for a patent on the Lefort process for the manufacture of ethylene oxide. This German patent to Walter describes the use of steam and metallic catalysts, silver among others, in the manufacture of formaldehyde by the oxidation of ethylene. Due to my mistaken understanding of the chemistry involved in the Lefort process I mistakenly assumed, after reading the said German patent, that the process, which was the subject matter of United States application Ser. No. 600,578, was like the process described in "Example 3", using the catalysts described at lines 105 to 113, page 3, of German Patent No. 168,291 except for Lefort's use of a special activated silver catalyst.

The United States Patent Examiner cited Willstatter, Annalen des Chemie, Vol. 422, pages 36 to 46 in the second official action. This is an article describing the manufacture of formaldehyde by the oxidation of ethylene. The citation of this article led me to believe that the Examiner also thought

that the formaldehyde process was the same as the Lefort process and I again mistakenly believed that this was the fact since I did not understand the real invention.

Solely by reason of my mistaken concept of the process of M. Lefort's invention and my mistaken and erroneous understanding of the true relation of his process to the prior art, I permitted the claims of Lefort's application Serial No. 600,578 to be restricted to narrow and specific embodiments of the invention therein described, and failed originally to draft claims of scope broader than the claims of said application as filed.

L. Guitzand

Sworn to and subscribed before me this 30th day of March, 1937 at Paris, France.

United States Consul

JOHN [illegible]
Vice-Consul of the [illegible]
of [illegible]

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AM[illegible] GENERAL
$2.00
Frs. 44.00
FRANCE

Filed Sept. 25, 1936 (3)

APR 10 1937

U. S. PATENT OFFICE
APR 12 1937
DIVISION 59

A F F I D A V I T

DISTRICT OF COLUMBIA)
) ss:
CITY OF WASHINGTON)

HERMAN JAKOBSSON, being duly sworn deposes and says:

THAT he resides at 228 Spruce Avenue, Takoma Park, D. C., and that he is an attorney duly registered and entitled to represent applicants before the Patent Office; that he was employed in the office of Marks & Clerk, National Press Building, 14th and F Streets, N.W., Washington, D. C. and in the office of the firm of Glascock, Downing & Seebold, of the same address, since the formation of the latter firm and until March, 1937; and that his successive employment by the two said firms covered the entire period during which the Lefort application, Serial No. 600,578 was pending in the Patent Office.

THAT he was solely responsible for the filing in the Patent Office of the said application Serial No. 600,578 and all amendments thereto; that he filed the said application exactly in the form in which it was received from Messrs. Elluin & Barnay, Paris, France; and that all amendments thereto were made and filed by deponent only upon authority or directions from Elluin & Barnay.

Deponent further says that he forwarded references cited in the prosecution of the said application to Elluin & Barnay for their consideration and that he did not attempt to understand the said invention and its relation to the cited

references with a view to distinguishing the said invention from the references cited; but that he left the consideration of the patentability of the said invention over the cited references wholly to Elluin & Barnay, and by arrangement with the latter acted only to transmit communications from and to the Patent Office.

Herman Jacobson

Sworn to and subscribed before me this 3rd day of April, 1937 at Washington, D. C.

[illegible]
Notary

APR 5 '37

IN THE UNITED STATES PATENT OFFICE

Div. 59, Room 4709 : Serial No. 102,613

T. E. Lefort : Filed Sept. 25, 1936

PROCESS FOR PRODUCING OLEFINE OXIDES

Hon. Commissioner of Patents

Washington, D. C.

Sir:

Supplementing the amendments to this application filed April 10, 1937, the following amendment is requested:

Claim 19, line 11, change "such as" to -- having the catalytic characteristics of --

Entire for allowance

REMARKS

The amendments to this application and the other papers filed April 10, 1937 were briefly discussed with the Examiner at a conference on that date, and again on April 15, 1937. The Examiner's courtesy in considering those papers and granting the further interview is acknowledged.

The foregoing amendment to claim 19 is made because of the Examiner's opinion expressed at the conference that the definition of the catalyst in the claim lacks adequate precision. This view is not believed to be completely valid, and claim 19 taken in the light of the specification is believed properly to define the catalytic materials for use in the process. However, the claim is being amended to a form which should remove this difference of opinion, and the amended form is submitted to be plainly definite in all respects. It is clear that an infringer cannot escape liability in the adoption of the process of claim 19 merely by replacing silver with an equivalent catalytic material otherwise within the class defined

79.

by the claim and pointed out in the description. There is no prior art cited, or known to applicant, which discloses applicant's process or any catalyst therefor. The invention is of pioneer character, and it is to be understood that applicant, by the present amendment, is not admitting any limitation on the scope of protection to which he is entitled. Applicant is endeavoring to comply with the formal requirements of the Examiner, and will look to the Courts later, if it becomes necessary, for interpreting the claims in the broad scope commensurate with the invention which has been made. Accordingly, applicant is willing to employ the amended language of this claim if it is more in conformity with the Examiner's viewpoint.

Other matters considered with the Examiner at the conference need not be restated here, since they are covered in full by the papers filed on April 10, 1937.

The original Letters Patent No. 1,998,878, surrender of which was tendered in the Petition for reissue of said patent submitted in this application, are enclosed. It is respectfully asked that this application be passed to issue at an early date.

Respectfully,

Eugene S. Greenwald
Attorney for Applicant

New York, N. Y.
April 15, 1937

F/D

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DEPARTMENT OF COMMERCE

UNITED STATES PATENT OFFICE

WASHINGTON

April 15, 1937.

Theodore Emile Lefort, Assor:

Sir:

Your application for Reissue for Patent No. 102,613 for improvement in process for the production of ethylene oxide, has been examined and allowed.

The patent will be forwarded to you as soon as practicable, in due order of business.

Very respectfully,

Thomas E. Robertson
Commissioner of Patents.

PATENT OFFICE
MAY 18 1937

Charles C. Scheffler
30 East 42nd Street,
New York, N. Y.

102613

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11—6041

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DEFENDANT'S EXHIBIT 6

FRENCH REPUBLIC

MINISTRY OF COMMERCE AND INDUSTRY

DEPARTMENT OF INDUSTRIAL PROPERTY

Patent of Invention

Group 14 — Class 1 No. 729,952

PROCESS FOR OBTAINING ETHYLENE GLYCOL

Societe Anonyme: SOCIETE FRANCAISE DE CATALYSE GENERALISEE, Residing in France (Seine)

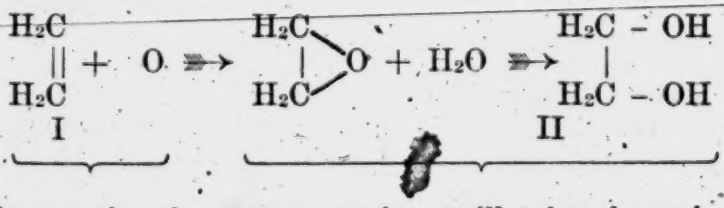
Filed March 27, 1931 at 4:20 p.m. in Paris

Granted May 3, 1932—Published Aug. 4, 1932.

(Patent of invention the grant of which has been deferred in accordance with article 11, paragraph 7 of the law of July 5, 1844 as amended by the law of April 7, 1902).

The invention has for its object a process for obtaining ethylene glycol which consists in subjecting ethylene derived from any source whatever; coke-oven gas, hydrogenation of acetylene, dehydration of ethyl alcohol, etc., to the simultaneous action of atmospheric oxygen and water.

The reaction underlying this process may be envisaged in the following manner:



In practice these two reactions will take place simultaneously at a temperature of 150 to 250° C. and a minimum pressure of 50 kg. although tests have shown that the reaction took place at atmospheric pressure.

As a catalyst one may use either antimony, or arsenic, or their compounds, or a mixture of these two elements and of their compounds.

Method of operation:—One may use high pressure steel equipment having two compressors, one for compressing air and the other for compressing ethylene, although it does not a priori appear impossible to compress a mixture of these two gases in one and the same compressor by keeping the mixture outside the explosive limits.

These two gases are passed into a reaction tube containing one of the aforementioned catalysts and heated to a temperature of about 200° C., the reaction tube being such that it will withstand a pressure of several hundred kilograms. This tube is moreover connected with a circulation pump permitting the introduction of water under pressure.

The reaction between the ethylene, atmospheric oxygen and water will take place in this tube. A continuous operation may be achieved by regulating the rates of flow. The glycol thus formed may be separated from the water by simple distillation.

Resumé

1. Process for obtaining ethylene glycol by the simultaneous action of atmospheric oxygen and water on ethylene;

2. This reaction is preferably carried out under a minimum pressure of 50 kilograms; the pressure may reach several hundred kilograms without inconvenience;

3. The reaction temperature is preferably maintained between 150 and 300° C.;

4. The catalysts used are particularly arsenic, antimony, their compounds, their mixtures, or mixtures of the latter;

5. By avoiding the addition of water to the reaction one can obtain solely ethylene oxide.

Societe Anonyme: SOCIETE FRANCAISE DE CATALYSE GENERALISEE

By power of attorney:
Elluin and Barnay.

FRENCH REPUBLIC

MINISTRY OF COMMERCE AND INDUSTRY

DEPARTMENT OF INDUSTRIAL PROPERTY

First Addition
To Patent of Invention
No. 729,952

Group 14 — Class 1 No. 41,255

PROCESS FOR OBTAINING ETHYLENE GLYCOL

Societe Anonyme: SOCIETE FRANCAISE DE CATALYSE GENERALISEE residing in France (Seine)

(Principal patent applied for March 27, 1931)

Filed July 4, 1931 at 2:12 p.m. in Paris.

Granted August 30, 1932—Published Dec. 2, 1932.

(Certificate of addition the grant of which has been deferred in accordance with article 11, paragraph 7 of the law of July 5, 1844 as amended by the law of April 7, 1902).

The object of the process of the principal French patent for "Process of obtaining ethylene glycol", dated March 27, 1931, consists in subjecting ethylene to the simultaneous actions of oxygen and water to obtain ethylene glycol.

In one method of carrying out this process air, ethylene and water are introduced under pressure into a chamber containing a catalyst and heated to about 200° C.

The catalysts referred to in the principal patent are antimony, arsenic, or their compounds, alone or in admixture.

The present addition has for its object the disclosure of other catalysts which in the course of experimentation have been found to be efficacious.

These various catalysts are the following:

1. A mixture of antimony, bismuth, silver, lead, arsenic, nickel and tin in variable proportions.

2. Bismuth alone.
3. Mixtures of antimony, lead, nickel and silver.
4. Mixtures of bismuth, nickel, silver and lead.
5. Mixtures of antimony, bismuth, nickel.
6. Mixtures of antimony, bismuth, silver.
7. Mixtures of bismuth and nickel.
8. Mixtures of bismuth and silver.

And in general any mixture that can be made from the following metals: Antimony, lead, bismuth, silver, nickel, tin, arsenic, taken alone, or taken 2 by 2, 3 by 3, 4 by 4, etc., in variable proportions; mixtures, under the same conditions, of these metals with their oxides; mixtures of only the oxides of these metals under the same conditions.

Resumé

The object of the present addition is to indicate new catalysts suitable for carrying out the "Process for obtaining ethylene glycol" which forms the object of the principal patent dated March 27, 1931.

These catalysts are in general:

Any mixture that can be made from the following metals: antimony, lead, bismuth, silver, nickel, tin, arsenic, taken alone, taken 2 by 2, 3 by 3, 4 by 4, etc., in variable proportions.

Mixtures of these metals and their oxides under the same conditions.

Mixtures of only the oxides of these metals under the same conditions.

Societe anonyme: SOCIETE FRANCAISE DE CATALYSE GENERALISEE

By Power of attorney:
Elluin and Barnay.

FRENCH REPUBLIC

MINISTRY OF COMMERCE AND INDUSTRY

DEPARTMENT OF INDUSTRIAL PROPERTY

Second Addition
To Patent of Invention
No. 729,952

Group 14 — Class 1 No. 41,474

PROCESS FOR OBTAINING ETHYLENE GLYCOL

Societe Anonyme: SOCIÉTE FRANCAISE DE CATALYSE GENERALISEE residing in France (Seine)

(Principal patent applied for March 27, 1931).

Filed September 10, 1931 at 4:13 p.m. in Paris

Granted Oct. 25, 1932—Published January 10, 1933.

(Certificate of addition the grant of which has been deferred in accordance with article 11, paragraph 7 of the law of July 5, 1844 as amended by the law of April 7, 1902).

First addition No. 41,255.

The principal French patent dated March 27, 1931, for "Process for obtaining ethylene glycol" consists in subjecting ethylene to the simultaneous action of oxygen and water to obtain ethylene glycol.

The object of the first addition, dated July 4, 1931, to the said principal patent is to indicate catalysts other than those mentioned in the principal patent.

The purpose of the present addition is to specify that the formation of glycol obtained by the oxidation of ethylene by atmospheric oxygen, in the presence of water, is necessarily derived from the saponification of the ethylene oxide obtained in the first stage by direct oxidation of the ethylene. The mechanism, indicated in the principal patent and the first addition relative thereto, accordingly leads first to the production of ethylene oxide which by direct saponification gives glycol.

But tests made by the applicant show that the catalysts indicated do not enable one to obtain ethylene oxide by the oxidation of ethylene if the gases are dry. The presence of water is necessary for the production of ethylene oxide, even apart from any attempt to bring about saponification.

The mechanism for obtaining glycol from ethylene as indicated above is specified below by way of example. Silver in the form of a powder or in the form of gauze, either on a support or not, is placed in a tube, for example of silica, and after having heated the tube to a temperature between 250 and 400°, a mixture of ethylene, air and water vapor is passed therethrough. The gases coming out of the tube are passed into a series of wash bottles in order to absorb the ethylene oxide formed by the reaction. The liquid in the wash bottles is then saponified, either with or without catalysts, to obtain glycol.

A silver colloid can also be introduced into a high pressure tube which has been filled with water. Pure ethylene is then added under pressure in order to dissolve it in the water.

The tube is then heated to between 150 and 300° C. whereupon air is slowly introduced. When all the ethylene is transformed into ethylene oxide, a saponification is effected so as to obtain the glycol.

Resumé

The present addition to the principal French patent dated March 27, 1931, for "Process for obtaining ethylene glycol" and the first addition dated July 4, 1931, is characterized principally by the following points:

1. Obtaining glycol by the production of ethylene oxide and saponification.

2. Obtaining ethylene oxide by direct oxidation of ethylene by atmospheric oxygen in the presence of water vapor and in contact with the catalysts specified in the principal patent and in the first addition, particularly silver and its mixtures with bismuth, antimony, lead, tin, nickel.

3. The necessity of introducing water vapor into the reacting gases (ethylene and air) to obtain ethylene oxide in accordance with the processes indicated above.

4. Obtaining ethylene oxide and then glycol in the liquid phase in a pressure tube in the presence of colloidal silver, taking advantage of the high solubility of ethylene in water under pressure.

Societe Anonyme: SOCIETE FRANCAISE DE CATALYSE GENERALISEE

By Power of Attorney:
Ellain and Barnay.

FRENCH REPUBLIC

MINISTRY OF COMMERCE AND INDUSTRY

DEPARTMENT OF INDUSTRIAL PROPERTY

Third Addition

TO PATENT OF INVENTION

No. 729,952

Group 14 — Class 1. No. 41,484

PROCESS FOR OBTAINING ETHYLENE GLYCOL

Societe Anonyme: SOCIETE FRANCAISE DE CATALYSE GENERALISEE Residing in France (Seine)

(Principal patent applied for March 27, 1931)

Filed September 25, 1931 at 10:45 a.m. in Paris
Granted November 3, 1932—Published January 10, 1933
(Certificate of addition the grant of which has been deferred in accordance with article 11, paragraph 7 of the law of July 5, 1844 as amended by the law of April 7, 1902).

First Addition No. 41,255 Second Addition No. 41,474

The process which is the object of the principal French patent for "Process for obtaining ethylene glycol" dated March 27, 1931, consists in subjecting ethylene to the simultaneous action of oxygen and water in the presence of a catalyst to obtain ethylene glycol.

Various catalysts suitable for carrying this process into practice have been disclosed in the above principal patent and in its first addition.

A method of operation described in a second addition consists in passing a mixture of ethylene, air and water vapor into a tube of refractory material containing the catalyst and heated to a temperature of between 250 and 400°. On leaving the tube, the gaseous mixture is passed into wash bottles the liquid of which is then saponified to obtain glycol.

The present addition has for its object an improvement in the process of the principal patent. This improvement consists in introducing hydrogen into the gaseous mixture of ethylene, air and water vapor.

The quantity of hydrogen introduced is at least 5% of the total mixture.

The reaction is thus greatly facilitated and the yield considerably increased. The proportion of hydrogen may be varied with experimental conditions, and particularly with the temperature and pressure.

Resumé

The present addition to the principal patent for "Process for obtaining ethylene glycol", dated March 27, 1931, has for its object an improvement in this process characterized in that hydrogen is introduced into the gaseous mixture of ethylene, air and water vapor, the passage of which into a heated chamber in the presence of a catalyst brings about the basic reaction of the process.

The proportion of hydrogen may be varied with the temperature and pressure. It constitutes at least 5% of the total gaseous mixture.

Societe Anonyme: SOCIETE FRANCAISE DE CATALYSE GENERALISEE

By Power of attorney:
Elluin and Barnay.

FRENCH REPUBLIC
MINISTRY OF COMMERCE AND INDUSTRY
DEPARTMENT OF INDUSTRIAL PROPERTY

Fourth Addition
To Patent of Invention
No. 729,952

Group 14 — Class 1. No. 41,810

PROCESS FOR OBTAINING ETHYLENE GLYCOL

Societe anonyme dite: SOCIETE FRANCAISE DE CATALYSE GENERALISEE residing in France (Seine)

(Principal patent applied for March 27, 1931)

Filed December 19, 1931 at 4:47 p.m. in Paris
Granted January 21, 1933—Published April 21, 1933

(Certificate of addition the grant of which has been deferred in accordance with article 11, paragraph 7 of the law of July 5, 1844 as amended by the law of April 7, 1902).

First Addition No. 41,255
Second " No. 41,474
Third " No. 41,484

The principal French patent dated March 27, 1931, for "Process for obtaining ethylene glycol", has for its object a process for obtaining ethylene glycol which consists principally in subjecting ethylene to the simultaneous action of atmospheric oxygen and water in the presence of catalysts under atmospheric or superatmospheric pressure.

Among the catalysts referred to is silver, and in the third addition to the principal patent there is reference to the introduction of hydrogen into the mixture of ethylene, air and water vapor in order to facilitate the reaction.

The present addition has for its object modifications and improvements in the process described in the prin-

cipal patent characterized by the following points, applicable either separately or in combination:

a. The silver is activated by introducing thereinto small quantities of gold, copper and iron;

b. As catalysts one may use the metals: gold, copper, iron, mixed or not, and in all proportions;

c. The yield of the reaction is increased by diminishing the CO_2 which is formed, by introducing a suitable quantity of water into the reaction, and by initially admixing a suitable volume of CO_2 with the gaseous reactants;

d. To improve the yield of ethylene oxide the synthesis is carried out under a pressure less than atmospheric.

Experiments have in fact shown that silver can be greatly activated by the introduction of small quantities of gold, copper and iron.

Thus, a mixture containing silver, gold, copper and iron gives very good results and permits of a specific reaction; the only foreign product obtained in the reaction is CO_2 which is easily removed. Only traces of aldehydes are formed.

The catalytic mixtures may comprise

Silver, gold, copper, iron Silver, gold, copper Silver, gold Silver, copper, iron Silver, copper Silver, iron Copper, iron	In all Proportions.

As indicated above, one may use as catalysts the metals: gold, copper, iron, either in admixture or not and in all proportions.

Moreover, one has established that the reaction producing the CO_2 is, contrary to one's previous belief, an oxidation reaction independent of that which produces ethylene oxide and of that which produces aldehydes.

From experiments of the applicant, it results that if water in suitable quantity is introduced, not only is the reaction facilitated, as indicated in the third addition, but in addition, the reaction producing CO_2—probably by direct oxidation of ethylene in accordance with the following equation:

$$C_2H_4 + 3O_2 = 2H_2O + 2\,CO_2$$

is checked, due—probably—to the partial pressure of the water. From these experiments one may conclude that if a certain quantity of CO_2 is introduced, in addition, initially into the reacting gases, the partial pressure of the CO_2 will intervene and the reaction by which ethylene is oxidized to CO_2 will be completely checked, resulting in a considerable increase in the yield of the operation. Moreover, it is established that when the synthesis is carried out under reduced pressure the yield of ethylene oxide is improved.

Resumé

The present addition to the principal patent dated March 27, 1931, has for its object certain modifications and improvements in the process described in the principal patent and in the third addition thereto, characterized especially by the following points, applicable separately or in combination:

a. Silver is activated by introducing thereinto small quantities of gold, copper and iron;

b. As catalysts one may use the metals: gold, copper, iron, either mixed or not and in all proportions;

c. The yield of the reaction is increased by diminishing the CO_2 which is formed, by introducing a suitable quantity of water into the reaction, and by initially admixing a suitable volume of CO_2 with the reacting gases.

d. To improve the yield of ethylene oxide the synthesis is carried out under sub-atmospheric pressure.

Societe Anonyme dite: SOCIETE FRANCAISE DE CATALYSE GENERALISEE

By Power of attorney:
Elluin and Barnay.

FRENCH REPUBLIC
MINISTRY OF COMMERCE AND INDUSTRY
DEPARTMENT OF INDUSTRIAL PROPERTY

Patent of Invention
No. 739,562

Group 14 Class 1

PROCESS FOR OBTAINING ETHYLENE OXIDE, PARTICULARLY FOR THE PURPOSE OF PREPARING ETHLYENE GLYCOL AND ITS DERIVATIVES

Societe Anonyme dite: SOCIETE FRANCAISE DE CATALYSE GENERALISEE residing in France

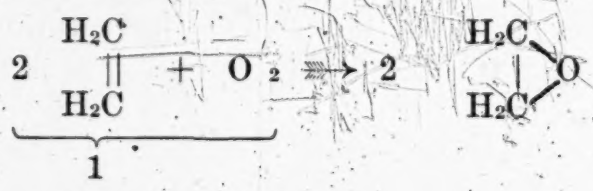
(Seine)

Filed October 3, 1931 at 4:30 p.m. in Paris
Granted November 3, 1932—Published January 13, 1933

(Patent of invention the grant of which has been deferred in accordance with article 11, paragraph 7 of the law of July 5, 1844 as amended by the law of April 7, 1902).

The present invention has for its object a process for obtaining ethylene oxide which consists principally in subjecting ethylene to the simultaneous action of atmospheric oxygen and water in the presence of a catalyst and hydrogen.

The hydrogen probably acts as an accelerating agent for the basic reactions of the process which may be expressed in the following form:



This reaction takes place at atmospheric pressure but for the industrial application of the process the pressure may be, for example, 50 kilograms per square centimeter at a temperature of between 150 and 400° C.

The following catalysts may be employed:

1. A mixture of antimony, bismuth, silver, lead, arsenic, nickel and tin in variable proportions.

2. Silver alone;
bismuth alone;
antimony alone.

3. Mixtures of antimony, lead, nickel and silver.

4. Mixtures of bismuth, nickel, silver and lead.

5. Mixtures of antimony, bismuth, nickel.

6. Mixtures of antimony, bismuth, silver.

7. Mixtures of bismuth and nickel.

8. Mixtures of bismuth and silver.

And, in general, any mixture that can be made from the following metals: antimony, lead, bismuth, silver, nickel, tin, arsenic, taken alone, taken two by two, three by three, four by four, etc., in variable proportions; mixtures of these metals with their oxides, under the same conditions; mixtures of only the oxides of the metals, under the same conditions.

The ethylene can be derived from any source; coke oven gas, hydrogenation of acetylene, dehydration of ethyl alcohol; and others.

Water can be introduced into the reaction chamber either in the liquid state or as steam.

The oxygen can be the oxygen of the air, this latter gas being introduced in the reaction.

Described below, by way of example only, are various methods of carrying out the process:

Method of operation: 1.—In an apparatus capable of resisting high pressures one compresses separately by means by suitable compressors, ethylene and air.

A mixture of air and ethylene may also be compressed, all necessary precautions being taken to prevent an explosion.

The two gases, together with hydrogen, are passed into a reaction tube resistant to pressures of several

hundred kilograms containing one of the catalysts indicated above and heated to a temperature, for example, of 200° C. The tube is also connected with a circulation pump permitting the introduction of water under pressure.

The reaction between the ethylene, the oxygen of the air, and the water takes place in the tube. Continuous operation may be had by regulating the rates of flow. The ethylene oxide thus formed is separated from the other gases, for example, by condensation.

Method of operation: 2.—Silver in the form of a powder, or in the form of gauze, either supported or not, is introduced into a tube made, for example, of silica, and after heating the tube to a temperature between 150 and 400° C., a mixture of ethylene, air, water vapor and hydrogen is passed therethrough. The proportion of the latter gas amounts to at least 5% of the total mixture. The ethylene oxide produced may be separated from the gases which emerge from the tube.

Method of operation: 3.—Colloidal silver is introduced into a high pressure tube filled with water. Pure ethylene is then added under pressure in order to dissolve it in the water.

The tube is then heated to between 150 and 400° C., whereupon air and hydrogen are slowly introduced. The introduction of air is stopped when all the ethylene has been transformed into ethylene oxide.

From the ethylene oxide produced in accordance with the above processes, one may obtain ethylene glycol by simple saponification, or by other known methods any derivatives of ethylene glycol.

The reaction for producing ethylene glycol may be expressed as follows:

$$C_2H_4O + H_2O \Longrightarrow \begin{matrix} H_2C - OH \\ | \\ H_2C - OH \end{matrix}$$

Tests made by the applicant have shown that in the presence of the catalysts specified, water, in the form of

steam or not, considerably favors the reaction of the production of ethylene oxide.

Resumé

The invention has for its object a process for producing ethylene oxide characterized principally in that ethylene is subjected to the simultaneous action of atmospheric oxygen and water in the presence of a catalyst and hydrogen.

The catalysts suitable for carrying out the process are all the mixtures that can be made from the following metals: antimony, lead, bismuth, silver, nickel, tin, arsenic, taken alone, taken two by two, three by three, four by four, etc., in variable proportions.

Mixtures of these metals with their oxides under the same conditions.

Mixtures of only the oxides of these metals under the same conditions. Only the oxides of the above mentioned metals.

The reaction takes place at atmospheric pressure but it may be carried out advantageously under pressure at a temperature between 150 and 400° C.

One method of operation consists in passing a mixture of ethylene, air, water vapor and hydrogen into a tube of refractory material containing the catalyst, the tube being heated to a temperature between 150 and 400° C. On leaving the tube the gaseous mixture is passed into condensers which permit collecting the ethylene oxide produced.

The quantity of hydrogen introduced amounts to at least 5% of the total mixture.

From the ethylene oxide one may obtain ethylene glycol by simple saponification, or by any suitable treatment one may obtain the derivatives of ethylene glycol.

Societe Anonyme dite: SOCIETE FRANCAISE DE CATALYSE GENERALISEE

By Power of attorney
Elluin and Barnay.

FRENCH REPUBLIC
MINISTRY OF COMMERCE AND INDUSTRY
DEPARTMENT OF INDUSTRIAL PROPERTY

First Addition
To Patent of Invention
No. 739,562

Group 14 — Class 1 No. 41,811

PROCESS FOR OBTAINING ETHYLENE OXIDE, PARTICULARLY FOR THE PURPOSE OF PREPARING ETHYLENE GLYCOL AND ITS DERIVATIVES

Societe anonyme dite: SOCIETE FRANCAISE DE CATALYSE GENERALISEE residing in France (Seine)

(Principal patent applied for October 3, 1931)

Filed December 19, 1931 at 4:48 p.m. in Paris
Granted January 21, 1933—Published April 21, 1933.

(Certificate of addition the grant of which has been deferred in accordance with article 11, paragraph 7 of the law of July 5, 1844, as amended by the law of April 7, 1902).

The process described in the principal French patent for a "Process for obtaining ethylene oxide particularly for the purpose of preparing ethylene glycol and its derivatives", dated October 3, 1931, consists principally in subjecting ethylene to the simultaneous action of oxygen and water in the presence of a catalyst and hydrogen.

In the examples for carrying out this process described in the principal patent, the reaction takes place at atmospheric or superatmospheric pressure in the presence of catalysts among which is mentioned silver in colloidal form, or in the form of powder or gauze.

The present addition has for its object modifications and improvements in the process of the principal patent characterized by the following points, applicable separately or in combination:

a. The silver is activated by introducing thereinto small quantities of gold, copper, and iron;

b. As catalysts one uses the metals: gold, copper, iron, either in admixture or not, and in all proportions;

c. The yield of the reaction is increased by diminishing the CO_2 which is formed, by introducing a suitable quantity of water into the reaction and by initially admixing with the reacting gases a suitable volume of CO_2;

d. The synthesis is carried out under less than atmospheric pressure to improve the yield of ethylene oxide.

Experiments have, in fact, shown that silver may be activated by the introduction into this substance of small quantities of gold, copper and iron.

Thus a mixture containing silver, gold, copper and iron gives very good results and permits of a specific reaction; the only foreign product obtained in the reaction is CO_2 which may be easily removed. Only traces of aldehydes are formed.

The catalytic mixture may comprise

Silver, gold, copper, iron Silver, gold, copper Silver, gold Silver, copper, iron Silver, copper Silver, iron Copper, iron	In all proportions

As indicated above, one may use as catalysts the metals: gold, copper, iron, either in the form of mixtures or not, and in all proportions.

Moreover, one has established that the reaction producing the CO_2 is, contrary to one's previous belief, an oxidation reaction independent of that which produces ethylene oxide and of that which produces aldehydes. From experiments of the applicant, it results that if water

in suitable quantity is introduced, not only is the reaction facilitated, as indicated in the principal patent, but in addition, the reaction producing CO_2—probably by direct oxidation of ethylene in accordance with the following equation:

$$C_2H_4 + 3O_2 = 2H_2O + 2CO_2$$

is checked, due—probably—to the partial pressure of the water. From these experiments one may conclude that if a certain quantity of CO_2 is introduced, in addition, initially into the reacting gases, the partial pressure of the CO_2 will intervene and the reaction by which ethylene is oxidized to CO_2 will be completely checked, resulting in a considerable increase in the yield of the operation. Moreover, it is established that when the synthesis is carried out under reduced pressure the yield of ethylene oxide is improved.

Resumé

The present addition to the principal patent dated October 3, 1931, has for its object certain modifications and improvements in the process described in the principal patent, characterized especially by the following points, applicable separately or in combination:

a. Silver is activated by introducing thereinto small quantities of gold, copper and iron;

b. As catalysts one may use the metals: gold, copper, iron, either mixed or not and in all proportions;

c. The yield of the reaction is increased by diminishing the CO_2 which is formed, by introducing a suitable quantity of water into this reaction, and by initially admixing a suitable volume of CO_2 with the reacting gases;

d. To improve the yield of ethylene oxide the synthesis is carried out under subatmospheric pressure.

Societe anonyme dite: SOCIETE FRANCAISE DE CATALYSE GENERALISEE,

By Power of attorney:
ELLUIN AND BARNAY.

DEFENDANT'S EXHIBIT 42

Eighteenth
May
1933

E. L. Masthoff, Esq.,
De Bataafsche Petroleum Mij.,
30 Carel van Bylandtlaan,
The Hague, Holland.

My dear Masthoff:

The Shell Development laboratory at Emeryville is in correspondence with the firm: Givaudan-Delawanna Inc., 80 Fifth Avenue, New York, who may be interested in products like Methyl-Allyl-Chloride, Iso-Crotyl-Chloride, 2-3 Dichlor-Iso-Butane, and normal Propyl-Chloride, they also report that they are interested in 40,000 to 70,000 lbs. of Chlorhydrene. Mr. Steck, who is going East shortly will discuss these subjects with them.

In one of their letters they write the following:

> "Since I wrote you my first letter, I have received news from abroad that your good company has taken over the patent rights for the manufacture of *Ethylene Oxide* according to the process patented by the French Company "Societe de Catalyse Generalisee". This process, I understand, allows you to make Ethylene Oxide directly from Ethylene without going through the Chlorhydrene and it might well be that under such circumstances it might be advisable for us to use the Ethylene oxide provided it can be obtained at a reasonable price. On the other hand, you may not want to make it unless in very large quantities, and should this be the case, I am wondering whether you would be willing to let us have a license, that is, a manufacturing license only."

Will you please let us know:

Firstly: Did B.P.M. actually acquire this French patent No. 729,952?

Secondly: If so, have U.S. applications been made corresponding to this French patent?

Thirdly: And if so, has B.P.M. acquired also the rights to the U.S. patent applications?

Fourthly: Have you any information regarding actual results obtained by the process covered by the French patent 729,952?

If the process is good, it should be very attractive and we should like to work on its development. We have plenty of ethylene available at Shell Point for carrying out the necessary experiments on a semi-commercial scale.

Yours sincerely,

DP:B

DEFENDANT'S EXHIBIT 43

E.L.MASTHOFF

'S-GRAVENHAGE, 28th June 1933
CAREL VAN BYLANDTLAAN 30

AIRMAIL. 555

D. PIJZEL, Esq.,
c/o Shell Development Company,
100 Bush Street,
SAN FRANCISCO.

Cal., U.S.A.

CI (CC-OA) — June 28, 1933

My dear Pijzel,

My reply to your letter D N° 215 of the 18th May last has been delayed as we were just having conferences with the gentlemen of the "Société de Catalyse Généralisée" regarding their process of making ethylene oxide.

First of all, I shall answer your questions:

Firstly: B.P.M. have not acquired rights on the French patent N° 729.952, nor on any of the 4 subsequent French patents, nor on any other foreign application.

Secondly: One U.S. application comprising all the French patents has been filed, of which you will find a copy, translated into French, enclosed. We have been promised the original application, which will be sent to you on receipt.

Thirdly: see under firstly.

Fourthly: We have information on the process and its results in laboratory tests only. This information is contained in the enclosed copy of Dr Langedijk's report N° 5205.

We obtained the first details regarding this French process from the Hercules Powder Co's representative in Holland, Mr Riemersma. He told us that the Hercules Co in U.S.A. are interested in ethylene glycol for the manufacture of explosives but that the price Hercules buy it for, viz. ¢ 15/lb was too high for a more general application. As the price quoted in the market reports of American chemical periodicals is ¢ 25/lb, it seems to me that Hercules are either buying at a large discount or that Mr Riemersma kept his price information too low for some reason or other. Riemersma told us that the French patent N° 729.952 had attracted his attention and he had arranged a visit to the laboratoy of the Soc. de C. G., where he had gained a favourable impression of the process demonstrated to him on a laboratory scale, especially as the French people had informed him that the cost price, inclusive of capital charges, by their process was ¢ 5/lb. glycol.

As Riemersma was shortly going to the U.S.A., he intended to discuss with his Directors the process and a prospective acquirement of the U.S.A. rights by the Hercules Co. However, as Hercules had no ethylene and the Shell had and seeing that his company and ours were already working together in some respects, he intimated that perhaps the Shell would care to obtain these

rights and manufacture the glycol under some agreement for Hercules, or Hercules would buy the rights and have glycol made under these rights by Shell, or Shell and Hercules would buy the rights together. Anyway he asked us to study the process and arranged a visit of one of our Amsterdam chemists to the Soc. de C. G. The outcome of this visit is laid down in Dr. Langedijk's report in which he describes the process followed on a laboratory scale.

You will see from this report that the ethylene—in this case ethylene 97%—is oxidized in mixture with the tenfold quantity of air and certain quantities of steam at ordinary pressure and a temperature of abt 375°C over a catalyst. To all appearances the catalyst used is silver activated with small quantities of gold, copper and iron. The reaction gas from each pass, after extraction of C_2H_4O and part of the CO_2 by waterwash is, without any subsequent admixture, recycled through the apparatus. In three subsequent passes of the run witnessed by Langedijk, of 36.3 L ethylene originally contained in the fresh feed, 31.82 L C_2H_4 had reacted (3.8 L C_2H_4 being retained in the gas holder for reaction gas, and 0.68 L C_2H_4 still contained in the final end gas). According to the description in the report of the 3 stages of run 1 and taking the method of determination of the oxide as glycol to be the more trustworthy one, it appears that these 31.82 L are divided over the reaction products as follows:

11.31 L C_2H_4 as oxide	=	35.5%
11.95 " " " CO_2	=	37.5%
8.56 " " not accounted for	=	27.–%
		100.–%

As you will see from the report, Dr. Langedijk who himself analysed on products of side reactions in the ethylene oxidation, did not find any other compounds besides C_2H_4O and CO_2. It seems therefore that the late Prof. Henry, who was the inventor, succeeded in developing a catalyst which drives the reaction between C_2H_4 and oxygen into one specified direction, whereby the ethylene in about equal parts in converted to the oxide and CO_2 respectively.

As no side reactions can be detected, the Sᵉ de C. G. feel qualified to calculate their % oxide yields as set forth on p. 9 of the report, viz:

$$R = \frac{\text{ethylene converted to oxide}}{\text{ethylene to oxide} + \text{ethylene to } CO_2} \times 100$$

thereby neglecting the amount of C_2H_4 not accounted for, as they say this is due to mechanical losses in their laboratory equipment and inaccuracy of analysis methods.

Although Dr Langedijk agrees that by evading such losses by better experimentation, the % of ethylene not accounted for, should be materially decreased, it seems in my opinion that such a high loss of about 27% cannot easily be ascribed to leakages in such a rather simple apparatus under very little more than ordinary pressure, and I think it highly important to have this point cleared up.

If it should be confirmed that only mechanical losses are responsible for the deficiency in ethylene, and therefore the process really converts the C_2H_4 to oxide and CO_2 only, so that the above Soc. de C. G.'s yield formula would be correct, a yield of about 45% of oxide introduced (see p. 9 of the report) may be reckoned upon.

This is important according to Mr Franchon, as the I.G. who are negotiating for the acquirement of the process rights for the European countries, should have stated that the French process could only compete with the Goldschmidt chlorhydrine process if yields of at least 40% on ethylene introduced would be obtained.

As you will see from the enclosed minutes we had a conference with two gentlemen of the Soc. de C. G. at The Hague, following a preliminary discussion between them, Mr C. B. de Bruyn and myself in Paris.

The gist of this conference was that BPM. have obtained a six months' option on the rights applied for in the U.S.A. The first thing for Shell Development Co. to do would be to study the process from information furnished to them by B.P.M., thereafter advising B.P.M.

as soon as possible whether Shell Development after this study would still be interested in the process. If so, results of the experiments with Shell Dev. Gases, which in order not to lose time should immediately be sent to Amsterdam, would then be made.

As regards costprice for the oxide made in this French process, you will see that we have only the assertion by Mr Franchon that the maximum costprice for French conditions would be frs. 3.— per kg. glycol, based on a price of frs 0.66 per m3 ethylene (calculated at 100%).

As stated in the minutes sulphur compounds are detrimental to the catalyst's activity, but Mr Franchon asserts that he is able to purify the gases sufficiently to prevent such poisoning. If it should be decided, therefore, to send other gases containing C_2H_4 besides your Shellpoint ethylene fraction, it is not necessary to have them purified on your side.

For the experiments in Paris and presumably in Amsterdam 3 cylinders of 40 kg each for each kind of gas to be examined would be required. These gases should be sent as soon as possible and we should appreciate it to receive an analysis of the gases shipped. Please mark the cylinders CI . 58

It is rather strange that Dr Kunz of the Givaudan Delawanna Corp. should have submitted the information to you that Shell Development Co. had taken over the patent rights on the Soc.'s process, which creates the impression that possibly the Soc. are trying to play off our Company against third parties interested in the process for U.S., especially as the French gentlemen intimated here that Dupont de Nemours were interested too.

I may mention here that we have not heard from Mr Riemersma since his recent return from the U.S.A.; however, we shall have a talk with him within a few days and shall keep you posted about what he has to say regarding his Company's point of view on glycol production according to the process of the Soc. de C. G.

I also enclose a note from our OA Department on the patent side of the process for the guidance of your patent department. We should be pleased if you would cable

us your ideas together with the date of shipment of the cylinders of gases, in case you wish to have experiments made.

Awaiting your reply with much interest, I remain,

yours sincerely,

E. L. MASTHOFF.

Encls: (*in duplicate*)

translation U.S.A. application. (one copy)
Report N° 5205 by Dr Langedijk.
Minutes of discussions.
Memo from our OA dept.
The 5 French patents

cc. Mr De Bruyn.

P. S. The memo from our O.A. Dept. has not been finished yet, and will be sent you by next mail. I enclose 2 copies of the original U.S.A. application 600,578, just received.

E. L. M.

DEFENDANT'S EXHIBIT 46

TRANSLATION.

B.P.M. LABORATORY REPORT NO 5205.

TITLE: Report on a visit to the "Société francaise de Catalyse généralisée" at Paris-Nanterre on March 30th and 31st and April 8th 1933 to judge their process for manufacturing ethylene oxide and glycol.

AUTHOR: Dr S.L. Langedijk, B.P.M. laboratory, Amsterdam.

SUMMARY: A description is given of the experiments made by the S.F.C.G. for converting ethylene-air mixtures in the

presence of a catalyst discovered by the S.F.C.G. at a temperature of 375°C. and at practically atmospheric pressure.

CONCLUSION: Starting from a mixture of practically pure ethylene and air in the ratio 1 : 10, this can be converted in three cycles through the apparatus to such an extent that there is practically no ethylene left. In the first cycle 2,5 gr. steam is added per liter gas mixture, in the second 1,4 gr. and in the third 0,7 gr. No formaldehyde, acetaldehyde, formic acid or carbon monoxide are formed during the reaction. Exclusively ethylene oxide (abt 40%), CO_2 (abt 40%) and a trace of glycol are found as reaction products. With more accurate methods of analysing and more expert experimenting the part not accounted for may certainly be reduced to much less than the 20—30% found in this case.

The S.F.C.G. method gives a better yield in oxide than the direct oxidising methods described so far; it remains to be proved by further experiments and careful calculations whether the S.F.C.G. method is preferable to the chlorhydrine method and whether it is directly suitable for technical ethylene.

Anticipating a consideration of the process from a patent technical point of view by the Patent Department, the author states as his personal opinion that the only characteristic feature of the process is the catalyst found by the S.F.C.G.; the activity and selectivity of the catalyst determine the other reaction condition, each of which (though having less effect) has already been mentioned in publications for the oxidation of ethylene with air or oxygen.

REPORT NO. 5205.

REPORT ON A VISIT TO THE "SOCIÉTÉ FRANÇAISE DE CATALYSE GÉNÉRALISÉE" AT PARIS-NANTERRE ON MARCH 30TH AND 31ST AND APRIL 8TH 1933 TO JUDGE THEIR PROCESS FOR MANUFACTURING ETHYLENE OXIDE AND GLYCOL.

The process for manufacturing ethylene oxide by oxidation of ethylene with air described in this report was demonstrated to me by the "Société Francaise de Catalyse Généralisée (abbreviated S.F.C.G.) in their laboratory at Nanterre, about 15 Km. west of Paris.

The Société Lyonnaise d'Electricité et d'Eau" (abbr. S.L.E.E.) have large gasworks with coke plant at Nanterre; the S.F.C.G. had rented the laboratory from the S.L.E.E., but otherwise these two companies seemed to be only very loosely associated.

In their patents concerning the manufacture of ethylene oxide and glycol by direct oxidation of ethylene (contingently in the presence of water) with air[1], the S.F.C.G. describe many methods of performing their process. However, when demonstrating the process to me, they omitted much of what they claim in their patents to be of advantage: instead of applying high pressure they worked at practically atmospheric pressure; the reaction took place at a temperature considerably over 300°C.; no hydrogen was added to the gas mixture; etc. In reply to a direct question whether this manner of working did not give an unsatisfactory idea as to the yield attainable, I was informed that the method followed for the demonstration yielded practically as much oxide as the modifications described in the patents. All that was absolutely necessary was:

a. to add an ample quantity of steam during the reaction (which, contrary to what is stated in the patents, gives rise to the formation of only very little glycol);

[1] So far only the French patents Nos. 729,952 and 739,562 of the S.F.C.G. concerning this subject have been published.

b. to use the specific catalyst discovered at the time by the late Prof. Ch. Henry, in regard to which no information at all was to be obtained.

It was further desirable:

c. to use a mixture of ethylene and air in the ratio 1 : 10 i.e. ethylene : $O_2 = 1 : 2$;

d. to apply a temperature of abt 375°C, or with lower concentrations of C_2H_4 at slightly higher temperature.

e. to work with high gas velocity.

* * *

When considering in more detail the characteristic features of the process demonstrated by the S.F.C.G. the following particulars may be mentioned.

1. Composition of the initial gas:

Primarily a mixture of 1 vol. pure ethylene and round 10 vol. air, with the approximate composition of 9 vol.% ethylene, 18 vol.% O_2 and 72 vol.% N_2, was used as base material.

After one cycle a gas of the following composition was obtained, 6,3 vol.% ethylene, 13,6 vol.% O_2, remainder $N_2 + CO_2$. This gas, which gave equally good yields as the primary intake gas, might also be formed as follows:

6,3 vol.% ethylene + 29 vol.% inert gas + 13,6 vol.% O_2 +

51,1 vol.% N_2, i.e.

35,5% ethylene of 18% + 64,7% air, provided that under the reaction conditions the gases accompanying the ethylene are inert in regard to oxygen. In this case even a diluted technical ethylene would, therefore, be suitable.

The intake gas used for the 3rd cycle contained even abt. 3% ethylene on 8% O_2, i.e. abt. 60 vol.% ethylene of 5% on abt. 40 vol.% air.

Further tests would be required to ascertain whether:

a. the CH-compounds accompanying the technical ethylene behave as inert substances during the reaction,

b. the technical ethylene contains catalyst poisons and, if so, how these can be eliminated.

2. *Composition of the catalyst.*

About this no information whatever was supplied.

3. *Reaction temperature and pressure.*

Measured at the tube in the first and second cycles of the gas, the reaction temperature was about 375°C., this being raised in the third cycle to 400—450°C. without giving rise to an abnormal formation of CO_2. *The pressure slightly exceeded atmospheric pressure.*

4. *Addition of water.*

The quantities of water added to the gas mixture to be converted were:

	litres steam of 0°/760 mm
in the first cycle 200 cm³/hr on an average	249
in the second cycle 112 cm³/hr on an average	139
in the third cycle 58 cm³/hr on an average	72
in the cycle on April 8th 1933 233 cm³/hr on an average	289

5. *Quantity of gas led through:*

First cycle 395 l. in 270 min. = 87 l./hr.
Second " 314 l. in 220 " = 86 l./hr.
Third " 232 l. in 160 " = 87 l./hr.
Cycle on April 8th 1933 341 l. in 258 min. = 80 l./hr.

Concentration of ethylene in the mixture of gas and steam passing through the tube.

$$\text{1st cycle } \frac{87}{87 \div 249} \times 9 = 2{,}3\%.$$

2nd cycle $\frac{86}{86 \div 139} \times 6{,}3 = 2{,}4\%$.

3rd cycle $\frac{87}{87 \div 72} \times 3{,}0 = 1{,}7\%$.

cycle on April 8th 1933: $\frac{80}{80 \div 289} \times 9 = 2{,}0\%$.

Ditto concentration of oxygen.

$\frac{87}{336} \times 18{,}8 = 4{,}9\%$

$\frac{86}{225} \times 13{,}8 = 5{,}3\%$

$\frac{87}{159} \times 8{,}6 = 4{,}7\%$

$\frac{80}{369} \times 18{,}6 = 4{,}0\%$

Velocity of gas in the tube:

According to information from the S.F.C.G. the cross sectional area of the quartz tube (22 mm dia.) which unfilled is $\frac{n\,d^2}{4} = 381\ mm^2 = 3{,}81\ cm^2$, has to be reduced to 2,91 cm^2 when taking into account the (unknown) volume of the catalyst. Since, for instance, for the first cycle a total velocity of gas ÷ steam of 336 l. (0°, 760 mm) per hour is calculated from the data of the experiments, i.e. at 375°C.

$\frac{375 \div 273}{273} \times 336$ l. = 810 l./hr., the velocity of the

gas in *cm³ per cm² free section per second* can be calculated as:

$$\frac{810000}{2{,}91 \times 3600} = 77{,}3 \text{ cm}^3/\text{sec.}$$

For the second and third cycles, where less steam is added, this velocity is correspondingly lower and amounts to:

51,8 and 36,6 cm³/sec. respectively.

A few remarks have still to be made in regard to three questions to which no or only little reference has been made in the foregoing, viz.

1. Have the S.F.C.G. already worked out the process so far that it may be applied in practice after a little semi-technical work?
2. Does the process offer advantages as compared with the processes already applied in practice for manufacturing ethylene oxide or glycol from ethylene?
3. What is the characteristic feature of the process and is this feature adequately protected by the S.F.C.G. patents?

With reference to these questions the following is remarked:

1. Since the gentlemen of the S.F.C.G., possibly in view of the fact that the Cie de Béthune intend to exploit their process for France and are already working on semi-technical scale, were unwilling to supply information in regard to tests on a larger scale, only the impression can be given that the following points have still to be worked out:
   a. Can technical ethylene be used without having to eliminate catalyst poisons?
   b. Can technical ethylene be used without considerable concentration? As already remarked, this will principally depend on whether at the reaction temperature the gases accompanying the ethylene are also oxidised in the presence of the S.F.C.G. catalyst. Within certain limits the dilution of the ethylene is of little consequence.

c. Is it possible, by using a well-cooled washing tower, to absorb from the diluted oxide-containing gases the oxide to a reasonably concentrated solution, or is it moreover necessary to work under pressure to achieve this result?

d. Is it possible to make a satisfactory use of the heat of condensation of the large quantities of steam required for carrying out the process?

2. As already remarked, a very accurate calculation will be necessary to ascertain whether the S.F.C.G. process offers advantages as compared with the usual methods. Undoubtedly it has the advantage that no chemicals (chlorine, alkali; etc.) are required, but on the other hand it is possible to convert practically all ethylene into chlorhydrine, which can easily be concentrated, whereas according to the S.F.C.G. process at least 40% of the ethylene is burnt to CO_2, whilst the oxide is primarily present in a highly diluted state. Moreover, in the chlorhydrine synthesis only the ethylene itself is converted, which with oxidation (see question 1 b) is questionable.

3. As a matter of fact this question should be dealt with by the Patent Department and for this reason I will not go far into it. However, it should be stated that in my opinion the only characteristic feature of the process is the *catalyst*, it being possible *to trace all basic characteristics* of the process in the literature on this subject. Consequently it is very important how the S.F.C.G. patents will be worded in countries other than France where a careful examination of patentable matter of the application is made before publication, which will lead to the elimination of the known elements from the matter claimed. Particularly the Dreyfus patent (Brit. Pat. 387,372) runs parallel to the S.F.C.G. patent to such an extent that it is worthy of the greatest attention, although it is stated, probably unjustly, to claim a process for manufacturing glycol.

It might, therefore, be recommendable to negotiate not about patents but about a direct divulgence of the catalyst used, as this seems to be the only valuable element of the process.

DEFENDANT'S EXHIBIT 47

Report on the discussions (on June 17th 1933) concerning the Ethylene oxide process of the Soc. Fr. de Catalyse Généralisée.

The following gentlemen were present:

Mr Masthoff,
Mr Lefort,
Mr Franchon,
Mr Dijt,
Mr Langedijk,
Mr Steenackers,
Mr van Rossum,
Mr Schurink.—

1. Mr Lefort handed Messrs. Masthoff and Dijt a copy of a French translation of the specification of the U.S.A. patent application (No 600,578 dated March 2nd 1932). At our request the original U.S.A. specification will be sent to us.

The first official letter had already been received by the Soc. Fr. from the American Examiner and was said to refer only to formal matter, no anticipating material being cited in regard to the subject matter of the invention. Mr. Franchon remarked that they had been the first to raise and patent the problem of direct manufacture of ethylene oxide from ethylene by oxidation (a provisional research of the respective literature seems to confirm this statement).

Mr Dijt remarked that the examiner frequently first criticizes the form of an application before proceeding to examine the subject matter, so that in the subsequent official letters anticipating material might still be cited. The French gentlemen were quite at ease in this respect.

2. The five French patents (No 729,952 with patents of addition Nos 41255, 41474, 41484, and No 739,562) had been combined to one single application in the U.S.A. In the latter some further details are given concerning a silver catalyst activated with small quantities of gold, copper and iron. This is *not* to be found in the French

applications, although Mr Lefort contended that it is mentioned therein. Later on he stated that it had been taken up in a further patent of addition application (No 30011 dated December 19th 1931) which does not seem to have been published yet; a copy of this application will be sent to us. The American application is worded a little more precisely than the French patent, and Mr. Dijt was of opinion that, if the specification should be accepted with the claims as now on file, the catalyst would be adequately protected provided it falls under some of the claims following on the first claim.

The French gentlemen stated that for *manufacturing* the catalyst (physical state) some special manipulations were required which they were keeping secret, and which consequently were not disclosed in the application. Mr. Dijt remarked that in general this involves a certain risk both for themselves and for their licensees.

The catalyst has a specific effect, only ethylene oxide and carbon dioxide and no other oxidation products being formed.

3. Patents have been applied for in:

France, Germany, U.S.A., Italy, Belgium, Poland, Luxembourg, Roumania, Japan, England and Czecho-Slovakia, and not, therefore, in Holland and Canada where consequently manufacture and import of the product manufactured according to this process are free.

The French gentlemen stated that on Monday, June 19th, they would be leaving for Frankfurt to visit the I.G., who intend to acquire the rights of the whole of Europe excl. France and Italy.

In France the Cie des Mines de Béthune is investigating the process on a technical scale, whilst in Italy the Government was said to be interested. Further they wished to reserve Japan. It was stated that the I.G. wished to acquire the patent in order to apply it themselves and not only in order to prevent the exploitation by third parties.

It was remarked that the process was not patented in the British colonies and Dominions.

The French gentlemen were informed that the Group would be principally interested in the process for U.S.A.

4. In the U.S.A. we have available two sources of ethylene:

a. A fraction obtained when purifying the hydrogen for the ammonia process, which contains about 50% ethylene (45.9% C_2H_4, 23.4% CH_4, 30.7% C_2H_6).

b. Crack-gases, which, however, contain only 5 to 10% ethylene (sometimes even less).

Mr Franchon was of opinion that the first gas could be worked without difficulty; he was not so sure about the second gas, a content of 40-50% ethylene being required (according to him).

Dr Langedijk remarked that the gas re-circulated in the second and third cycles of the tests made in his presence at Paris had much smaller contents of ethylene and that nevertheless satisfactory yields (calculated on converted ethylene) had been obtained.

Mr. Franchon contended that in order to obtain a satisfactory yield the following combination of proportions was required in the reaction gas (in which combination no physical or chemical signification whatever can be found):

$$\frac{O_2}{C_2H_4} \times \frac{O_2 + C_2H_4}{\text{Total diluents}} = \text{abt. } 0{,}8 - 1,$$

With reference to figures from the tests made at Paris Dr Langedijk proved that this could not be true, since for the respective gas this "factor" was only 0,4 — 0,5. Mr Franchon then admitted that the figures cited by Dr Langedijk indeed showed that these values might suffice. The French Coke Oven Works obtain a coke furnace gas containing abt 2% ethylene, which is concentrated to 50%, which is said not to be very expensive.

It has still to be investigated whether crack gases containing also other unsaturated components are equally suitable for the reaction and whether the ethylene can be equally well concentrated.

5. It was discussed what further steps would now have to be taken. We stated that the Shell Development Comp. intended to examine the process in their laboratories themselves and requested the French gentlemen to inform us about the composition of the catalyst and supply further data required for carrying out the tests without difficulties.

However, the gentlemen did not care to do so, as according to their statements the suitability of the catalyst depends on a few special manipulations during manufacture which are not described in the patents and which they were unwilling to divulge to us before an agreement had been made.

We then requested them to despatch to the Shell Development Comp. the ready catalyst. This they were prepared to do, but they asked for a sum of Frs 500,000.—, on payment of which we would be entitled to experiment with their catalyst for six months. At the expiration of that period the money would either go to them in case the matter fell through or be settled with the payments to be made in the event of a license agreement being entered into.

We did not agree to this proposal, and suggested to ask the Shell Development Comp. to send samples of their gases to Europe in order to have tests made with them in Paris by the "Catalyse" under the supervision of one of our chemists. These tests might then be repeated at our Amsterdam laboratory in the presence of one of the gentlemen of the "Catalyse". It was agreed that the running of such tests would not bind us in any way towards the Soc. de Catalyse Généralisée.

In order to be able to submit more or less concrete proposals to the Shell Development Comp. the French gentlemen were requested to inform us about their conditions for

a. an exclusive license for the U.S.A.

b. an exclusive license for the U.S.A. plus the right of free sale over the whole world, with the exception of Europe and Japan, of the ethylene oxide and glycol manufactured in U.S.A. by the Group.

Within eight days Mr Lefort would confirm in writing the provisional arrangements made and name their conditions.

It was agreed that we should inform the Shell Development Comp. about the French process, the discussions held and the conditions of the Soc. de C.G.

Should the Shell Development Comp. after studying this information still be interested in the process, then the tests with their gases mentioned above would be carried out.

In order not to lose any time Shell Development Comp. would be asked to have the gases in question shipped at once. As it would take at least two months before the tests could be started, there would be ample opportunity in the meantime to study Dr Langedijk's report on the process and the patents.

Further it was discussed what time would be required for making the necessary arrangements and carrying out the tests. As it was calculated that in all about six months would be involved, we have been granted an option for six months until Dec. 31st 1933 without any commitment or payment by us.

Mr Lefort remarked that as a matter of fact we had now already obtained something from them, viz. the promise that in the meantime they would not negotiate with third parties, and that this promise was also worth something. This point was not discussed further, since —as was remarked on our side—it was in the interest of both parties to have the tests carried out.

6. Information was asked for about the cost price of the catalyst in order to enable us to determine the capital to be invested. On this point the French gentlemen were very reserved and stated that the catalyst, just as gold and silver, retained its value. Neither did they inform us about the life of the catalyst, which they stated to be very long, whilst the catalyst could easily be regenerated. The catalyst poisons are sulphur compounds (also arsenic).

7. Mr. Franchon remarked that glycol from ethylene according to their process could be produced in Europe

at a costprice of at most Frs. 3.—per kilo, incl. capital service, with an ethylene price of Frs. 0.66 per m^3 (calculated on 100%). The present selling price in America was stated to be Frs. 11.- — 14.- per kilo.

8. In reply to a question of Mr. Masthoff in regard to the data available for application of the process on a large technical scale, Mr Franchon stated that complete data for equipment etc. had been worked out by competent engineers of Construction companies and that these would be put at our disposal as soon as a contract would be closed.

DEFENDANT'S EXHIBIT 48

E. L. MASTHOFF

'S-GRAVENHAGE, July 6th, 1933.
CAREL VAN BYLANDTLAAN 30

—. BY AIRMAIL .—
D. PIJZEL, Esq.,
Shell Development Company,
100, Bush Street,
SAN FRANCISCO (Cal.)
U.S.A.

CI (CC-OA)—Société Française de Catalyse Généralisée

July 6, 1933

My dear Pijzel,

Further to my letter N°555 of the 28th June I would inform you as follows:

We received a letter from the Société Française de Catalyse Généralisée dated 28th June, of which you will find a copy enclosed.

On comparing the contents of this letter with the minutes of the conference sent to you with my above-men-

tioned letter you will notice that the people of the Société have introduced conditions which are totally in contradiction to what was agreed upon at The Hague. They now want a complete contract signed by both parties, to become effective if the results of the tests with our ethylene gas are in conformity with the tests made in March last, described in Dr Langedijk's report, and if we feel satisfied about the patent position.

From the minutes it is clear that no such thing has been discussed at all, and that it was agreed that neither the option of 6 months nor the results of tests with our ethylene, nor anything else would bind us.

You will also find enclosed copy of our reply of the 5th July to their letter, to which we added that we think their financial conditions too excessive to be discussible.

It is, of course, difficult for us on this side to estimate the value of their process for U.S.A. from the standpoint of commercial application, and you will be in a better position to judge this, but if I may venture an evaluation and take it that the patent position etc. is all right, I should think that a tenth of the cash payment asked for is about what we could consider plus a royalty of say maximum 0.5 French francs per kg ethylene oxide produced as such or in other products. I just heard from Riemersma of Hercules Powder Co. that they buy ethylene glycol at ¢ 12/lb for 10 ton lots. This is ¢ 26.4 per kg, and considering a costprice in U.S.A. of Fr.4.50/kg or ¢ 18 (all in dollar at par), instead of Fr. 3.—, I feel that Fr.0.5 or ¢ 2 royalty per kg oxide would be the utmost to go to.

However, it is for you to consider these questions and give us your advice. In the meantime we shall abide by what has been agreed upon in our conference of June 17th and if they agree and the tests with our base materials plus patent position have been found satisfactory, then I think the Société will have to furnish us with their complete data on equipment required, its price and operating costs before we discuss the financial conditions of the proposed deal.

Enclosed you will also find the note from our OA department on the patent side of the French process referred to in my letter of the 28th June.

As regards Hercules Powder Co.'s interest in this process, I heard from Riemersma that his directors do not consider to buy it.

Yours very truly,

E. L. Masthoff.

encl.:

copy of letter from S.F.C.G. dated 28th June,
" " " to S.F.C.G. " 5th July,
" " memo from OA Dept.

c. c. Mr. C. B. deBruyn.

DEFENDANT'S EXHIBIT 49

Translation

Société Française de Catalyse Généralisée

Paris, June 28, 1933

N. V. deBataafsche Petroleum Maatschappij
Carel v. Bylandtlaan 30
La Haye
Holland

Gentlemen:

First allow us to thank you for the excellent reception accorded to our agents during the call they made on you.

We are today in receipt of your letter of the 27th inst., and beg to be excused for not having written you earlier but our board of directors met only yesterday.

We are sending you enclosed herewith a copy of our U.S. patent in accordance with your desire.

On the other hand, it has been agreed upon that we shall repeat in our Courbevoie laboratory the experiments which you have witnessed some time ago and the result

of which has been recorded in a report dated March 31, with gases derived from sources of your own.

If you so desire these experiments will likewise be repeated in your Amsterdam laboratories. It is therefore important that you send these gases promptly to us by the expeditious route.

In short we agree in principle subject to the conditions set forth above to grant you a license in North America and facilities for selling products manufactured in Canada and the Dutch East Indies.

You asked us to indicate to you the main conditions of this grant.

The license rights would be acquired by you on payment, in cash, of the sum of frs. 2,000,000. (two million francs), and of a royalty of one franc per kg. of manufactured products.

Kindly advise us whether you agree on these bases; in the affirmative case we shall have a draft of the complete contract drawn up so as to put us in a position where we can exchange our signatures contingent on the successful outcome of the experiments.

In case the results of the experiments are consistent with the report of March 31, 1933 and you are satisfied with respect to the question of the patent the contract would ipso facto become final.

This signature would on our part be worth an agreement not to cede this right to anybody for the United States until the termination of the experiments.

As soon as your investigation of the patent is finished we would ask you to let us know your conclusions with regard thereto.

We are awaiting your reply and, as the case may be, your objections and ask you, Gentlemen, to accept the assurance of our most distinguished sentiments.

The Delegate Director
General Manager

(signature illegible)

Translation.

To

Société Française de Catalyse Généralisée
8 Avenue Percier
Paris (VIIIe)

La Haye, July 5, 1933

CC (CI-OA)

Gentlemen:

We acknowledge receipt of your letter of June 28 stating your conditions for a license covering the application of your process for the production of ethylene oxide, and also receipt of the copy of your American patent which copy has been sent, as agreed upon, with all the necessary details to our friends in California.

With respect to your confirmation of the agreement entered into with your Messrs. Franchon and Lefort we much regret having to observe that the confirmation is not in accordance with what had been agreed upon. This difference we presume must be attributed to a misunderstanding on your part.

In order to clear up this matter we are sending you enclosed herewith for your guidance a memorandum (in English with translation into French) drawn up after the discussions we had with your representatives on Saturday June 17, paragraph V of which precisely sets forth the agreements entered into. We shall appreciate receiving confirmation from you to the effect that you agree with the contents of this memorandum.

Concerning the cash sum of frs. 2,000,000.—and the royalty of 1 franc per kilogram of manufactured products which you ask, we feel bound to tell you that we are unable to take into consideration any payment of such magnitude.

If there is on your part any incentive to have an interview with us in order to clear up the misunderstanding we are entirely agreeable to receive your representatives.

In the expectation of hearing from you we are sending you our fervent greetings.

N. V. deBataafsche Petroleum Mij. (in pencil)

signature H. Jacobson (stamp)

Enclosures

DEFENDANT'S EXHIBIT 50

H. JACOBSON

's-Gravenhage, 17th July, 1933.
Carel van Bylandtlaan 30

VIA AIR MAIL.
D. Pyzel, Esq.,
100, Bush Street,
SAN FRANCISCO.

CC(CI) Ethylene-oxide.

July 17, 1933

My dear Pyzel,

Please find enclosed for your information copy of a letter from Société Française de Catalyse Généralisée, Paris, on the above subject, together with copy of our today's reply.

As you will see, the French gentlemen wish to fix the conditions for a licence before the 31st August 1933 and I should appreciate it very much if you could see your way to let us have your opinion on the process and its possibilities, together with your idea of the price we should pay, in the second half of August.

Thanking you in advance for the trouble to be taken,

Yours sincerely,

H. JACOBSON

Encs. 2 copies

DEFENDANT'S EXHIBIT 51

Translation.

Société Française de Catalyse Généralisée
8 avenue Percier
Paris (8e)

Paris, July 13, 1933

To

N. V. deBataafsche Petroleum Mij.
Carel v. Bylandtlaan 30
La Haye
Holland

V/R CC(CI-OA)

Gentlemen:

We have the honor to acknowledge receipt of your letter of the 5th inst.

Enclosed herewith please find a copy of the addition No. PV 30011 to patent No. 739562 dated Oct. 3, 1931.

In principle we are in accord with the terms of the report attached to your letter.

As concerns the option period we are likewise in accord in that you hold an option until Dec. 31st. It is however our formal desire, in order that this option period be granted you in a final manner, that we come previously to an agreement with respect to the financial conditions under which you will buy our process from us in case of the successful issue of the tests.

You must understand that it would be useless for us to bind ourselves for six months if we are never to come to an agreement with respect to the financial conditions.

It is therefore necessary for us to make provision for these conditions beforehand in the event of the successful issue of the tests. It seems to us that this agreement could be reached before Aug. 31 next.

For the present we give you until December 31 to make a decision. From now until such time as this agreement comes into force—and we think that this can be done by Aug. 31—we shall enter into no negotiations with other parties.

As concerns these conditions you tell us that they are too high. We are asking you therefore to make us counter-proposals with respect thereto.

We are entirely at your disposal for a return journey to La Haye and for renewed conferences with you on this subject, from Monday July 24 on.

Please accept, Gentlemen, the assurance of our most distinguished sentiments.

(signed) Lefort

Translation.

To
Société Francaise de Catalyse Généralisée
8 avenue Percier
Paris (VIIIe)

La Haye, July 17, 1933

CC(CI-OA)

Gentlemen:

We are in receipt of your letter of July 13 from which we gather that in principle you agree with us as to the wording of our report covering the discussions held in our office on Saturday, June 17.

With respect to the financial conditions for a contingent license on our process we are quite ready to negotiate with you with a view to fixing these conditions in case we should decide to acquire your rights for the United States. The Shell Development Co. of San Francisco who are interested in your process and for whom we act as go-betweens are now doing research work on the possibilities of your process and the products in the United States.

You understand that it is necessary to wait for the report before we are in a position to resume the negotiations with you. We asked our friends in California to send us the necessary informations as soon as possible, and hope to be able to resume the negotiations at the end of the month of August.

We are willing to believe that in the meantime you shall not enter into negotiations with other companies, and shall appreciate it if you can let us have your confirmation.

Please accept, Gentlemen, the assurance of our most distinguished sentiments.

N. V. DeBataafsche Petroleum Maatschappij.

DEFENDANT'S EXHIBIT 52

H. Jacobson

's-GRAVENHAGE, 25TH JULY, 1933
CAREL VAN BYLANDTLAAN 30

VIA AIR MAIL.
D. PYZEL, Esq.,
100, Bush Street,
San Francisco.

CC (CI) Ethylene-oxide.

July 25, 1933

Dear Mr. Pyzel,

Further to our letter of 17th July on the above subject I have pleasure in enclosing for your information copy of a letter from Société Française de Catalyse Généralisée, Paris, to Bataafsche, dated 20th July.

Yours sincerely,

for H. Jacobson
Van Rossum.

Enc. 1.

DEFENDANT'S EXHIBIT 53

Translation.

Société Française de Catalyse Généralisée
8 avenue Percier
Paris (VIIIe)
Paris, July 20, 1933

To N. V. DeBataafsche Petroleum Mij.
Carel v. Bylandtlaan 30
La Haye

Gentlemen:

We beg to acknowledge receipt of your letter of the 17 inst.

We shall therefore expect to hear from you before Aug. 31. From now until then we shall enter into no negotiations with another company as far as the United States are concerned.

We think it would help matters if the gases which your friends in California are to send, arrive here as soon as possible.

In case you need us for any reason whatever we are entirely at your disposal.

Please accept, Gentlemen, our most distinguished salutations.

(signed) Lefort.

DEFENDANT'S EXHIBIT 54

Report No. 1759

SHELL DEVELOPMENT COMPANY
EMERYVILLE

MONTHLY PROGRESS REPORT
AUGUST, 1933

By

H. Groll.

SUBJECTS: 708. Removal of Mercaptans from Olefines. (H. Groll and G. Hearne).

718. Glycols, Oxides and Related Substances. (H. Groll and H. de Jong).

1314. Isobutyric Acid and Allied Products. (H. Groll, G. Hearne, C.J. Ott and H. de Jong).

For the information of the Director of Laboratories only. Not for distribution.

No. 1759

718. Glycols, Oxides and Related Substances.
(*H. Groll and H. de Jong*).

All experiments on production of ethylene oxide from ethylene and air under conditions intended to imitate the Société Française de Catalyse Généralisée's process were futile. However, this by no means disproves the claims of the Société Française de Catalyse Généralisée. We could not find a catalyst of the right activity. Most of our catalysts did not oxidize the ethylene at all. Hopcalite however catalyzes complete oxidation to CO_2 and water even at 275°C. So it appears that there should exist some combination of catalyst which has just the right degree of activity. A detailed report on this is being prepared.

H. Groll

/IF
August, 1933

DEFENDANT'S EXHIBIT 58

/ Sixth
October
1933

D #439

De Bataafsche Petroleum Mij.,
30 Carel van Bylandtlaan,
The Hague, Holland.

Catalyst Composition: S.F.C.G. Process

Gentlemen:

I am herewith sending you the desired information regarding the approximate composition and method of preparation of catalysts for the ethylene oxide process of the S.F.C.G., which you requested in your cables No. 300 of October 2nd, and No. 853 of October 5th:

Catalyst #1

Pure silver was turned on the lathe to form small shiny turnings.

Catalyst #2

Silver turnings were placed in a dish and very clean mercury sprayed over it through a chamois bag with good stirring. The mixture was placed in a glass funnel, in order to drain off the excess mercury, and allowed to stand for about three days. At the end of this time, the mercury was removed under reduced pressure at 500°C.

Catalyst #3

100 parts of silver turnings and 5 parts of powdered copper (Naturkupfer C) were mixed in a flask. To this, 35 parts of mercury were added slowly while the flask was shaken vigorously. When all mercury had been added, about 8 parts of very dilute HNO_3 was added and the shaking continued for 10 minutes. The whole was then freed from water and the mercury removed under reduced pressure at 500°C.

Catalyst #4

Finely powdered metallic arsenic was mixed with silver turnings and heated quickly in a covered crucible to give an alloy rich in arsenic. This alloy was placed on the bottom of a graphite crucible and molten silver poured on top of it. The resulting block of alloy was melted again, covered with charcoal, stirred well, and poured into an iron mold. The arsenic content was about 4%.

The rod cast by this method was turned on the lathe and the turnings used as catalyst without further treatment.

Catalyst #5

1 part of tin was dissolved in very dilute HNO_3 and enough water added so that 60 parts of water were present. To this was added 1 part of each bismuth, silver, lead and nickel, as nitrates. When all were dissolved, 100 parts of 8-10 mesh pumice were added with good stirring.

The water was then evaporated off and the catalyst roasted until no more brown vapors were given off.

Catalyst #6

1 part of antimony, as Sb_2O_3, was melted on 100 parts of pumice in an electric oven. The catalyst was then prepared with the same constituents and in the same manner as Catalyst #5, but before roasting 1 part of arsenic was added as H_3AsO_4.

Catalyst #7

Same as #6, but without bismuth.

Catalyst #8

Same as #6, but without lead.

Catalyst #9

Same as #6, but without lead and tin.

Catalyst #10

Same as #6, but without antimony and bismuth.

Catalyst #11

Same as #6, but without antimony and lead.

Catalyst #12

So far only tried in unreduced state—"Hopcalite", as supplied by the Mine Safety Appliances Co. at Pittsburg, Pa., for use in gas masks.

Yours very truly,

SHELL CHEMICAL COMPANY
Original Signed by D. Pyzel

DP:B

DEFENDANT'S EXHIBIT 59

E. L. MASTHOFF

's-GRAVENHAGE, 2nd October, 1933.
CAREL VAN BYLANDTLAAN 30

BY AIRMAIL.
D. PIJZEL, ESQ.,
c/o. Shell Development Co.,
100, Bush Street,
SAN FRANCISCO.
10/2/33

CI (CC-OA)

My dear Pijzel

From your cable No 154 of the 28th September I duly noted that the Emeryville experiments re the ethylene-oxide process of the Soc. de Catalyse Généralisée were completely negative and that you could not give us your recommendations which would put us in a position to make a counter-proposal to the Soc. de Cat. Gén.

With my letters of the 28th June and 6th July I submitted to you all information available re the French process with the idea that Shell Development would study the process from this information and compare it with the chlorhydrine process with which Shell Development are experimenting. That Shell Development should make their own experiments on the French process did not come into consideration, because it was believed that satisfactory results could not be obtained without knowing the exact composition of the French catalyst. This now seems to be substantiated by your cable No 154.

Of course, a comparison as mentioned above—for which certain yields in the French process would have to be taken as a basis, e.g. 40 and 45% yield as oxide of the ethylene introduced—could not claim to be exact. It would as a matter of fact be principally a comparison on a basis of the cost of ethylene and chemicals consumed, but I thought that the result might in the first place enable Shell Development to express an opinion as to whether the French process had sufficient attractiveness

above the chlorhydrine process to warrant further negotiations on the acquisition of the U.S.A. rights, and the hope that the outcome of this comparison and a study of the matter from a marketing point of view, would enable you to express an opinion as to what would be a reasonable price to pay.

The experiments with ethylene containing gases of the Group's produce, either directly available as in the case of the Shell Point ethylene fraction or which could be made available from Dubbs gas or by special cracking of certain base materials, which were envisaged in co-operation with the Soc. de Cat. Gén., would only be taken after a favourable opinion on the French process had been expressed by Shell Development Co., whereas the results of these experiments would then serve as the deciding proofs with regard to the profitability of the French process.

I will, of course, discuss with you and Dr Williams this question during my forthcoming visit and I should very much appreciate it if in the meantime Shell Development would study the matter from the viewpoint as explained above, so that we may jointly give our recommendation to The Hague as soon as possible.

As already said above, the completely negative results of Emeryville's experiments seem to confirm our opinion that the patent applications disclose very little indeed of the essential part of the invention, viz. the catalysts required.

With their letter of 12th September, copy of which is enclosed, the Soc. de Cat. Gén. informed us that experiments based on the information in our possession, will not give satisfactory results and that additional information *not disclosed in the patents* is required, which secret information can only be provided by them.

It seems a rather imprudent move on the part of the Soc. de Cat. Gén. to make such a written statement, by which they would themselves confirm that their patent applications when attacked run the risk of being declared invalid on account of insufficient disclosure, whereas any outsider might get patent protection on a catalyst developed along the general information in the Soc. application, when this outsider claims a detailed description of such catalyst.

In view of this, we had, therefore, already decided to carry out experiments in the Amsterdam Laboratory on the French process, in the first place to satisfy ourselves that their statement is right that we cannot get satisfactory results when using the information contained in their patents only, and further to try to find ourselves those conditions by which a suitable catalyst can be developed.

Of course, you will be kept "au fait" of any findings by the Amsterdam Laboratory.

Yours sincerely,

E. L. MASTHOFF

encl.:
copy of letter from Soc. de Cat.
Gén. dated 12th Sept.

c.c. *Mr. De Bruyn.*

DEFENDANT'S EXHIBIT 60

Translation

SOCIETE FRANCAISE DE CATALYSE GENERALISEE

PARIS, le 12 Septembre 1933.

N. V. DE BATAAFSCHE PETROLEUM MIJ.,

LA HAYE.

CC(CI-OA)—

Gentlemen:

We have received your letter of September 4.

Before giving you a time option, which you have requested, until December 31 for example, we would like to be certain about several points.

In fact we do not understand why your friends in California have not been able, in all this time, to make a decision.

You tell us that they are doing research which will require still more time; that is what we do not understand, and we would like to know why their research takes such a long time. What research can they be doing?

Either this research concerns our patents, and in this case your California friends should have made up their minds. Or this research is of a technical nature, your friends for example are doing experiments; and if that is the case, we are then obliged to tell you that with the data they have on hand they will not be able to obtain satisfactory results.

Without complementary explanations from us as to the tricks of the catalyst, any experiments which they make can only be the cause of considerable loss of time.

It is for this reason that we do not see the necessity of waiting until the end of December.

Besides, you inform us that you will eventually be interested in Italy. Now, we are very much afraid, in view of the time which your California friends require for their decision, that we will have made an agreement in Italy before their response about America reaches us.

We will be very much obliged if you will be good enough to advise us regarding these various points, so that we can make a decision.

We would like to hear from you very soon, and await your reply we send you our good wishes.

l'Administrateur-Délégué
Directeur Général

DEFENDANT'S EXHIBIT 61
Nineteenth
October
1933

D #474

De Bataafsche Petroleum Mij.,
30 Carel van Bylandtlaan,
The Hague, Holland.

CI (CC-OA)

Re: Ethylene Oxide Process of the
S. F. C. G.

Gentlemen:

I refer to Mr. Masthoff's letter No. 580, of October 2nd, dealing with the ethylene-oxide process of the Soc. de Catalyse Generalisee.

I will discuss the contents of this letter with Mr. Masthoff when I meet him in Chicago next week, but in the meantime, I want to draw your attention to the fact that the object of the experiments carried out at the laboratory in Emeryville was to determine whether or not the disclosures made in the patent applications of the S. F. C.G. were sufficient to enable "anybody versed in the art" to carry out the process as is required, in order to make a U. S. patent valid. Apparently this is not so and I see from the second paragraph on page three of Mr. Masthoff's letter that the S.F.C.G. admit that the necessary information is not disclosed in the patents.

Under these circumstances these patents would be held invalid in this country, which means, of course, that they would have very little value for us. As I cabled you on August 29th, I consider that the royalty of 1 franc per kg. of ethylene-oxide is far too high, while a cash payment of two million francs would be out of the question.

Yours very truly,

SHELL DEVELOPMENT COMPANY

Original Signed by D. Pyzel

DP:B

DEFENDANT'S EXHIBIT 64

November 3, 1933

AIR MAIL

MR. H. JACOBSON
De Bataafsche Petroleum Mij.
30 Carel van Bylandtlaan
The Hague, Holland

Re: Ethylene Oxide/Glycol

My dear Jacobson:

Upon my arrival here in the beginning of this week, I found Hardonk's letter on the recent discussions with S.F.C.G. at the Hague, and I cabled yesterday Pyzel's and my comments as asked for.

You will see from this cable that we consider the scheme for further investigation of S.F.C.G.'s process and negotiations with them, as set forth in the resume of the discussions, to be satisfactory if revised in such way that cost prices derived from laboratory experiments only, are entirely disregarded as a basis for financial obligations on Bataafsche's part. * * *

If they would keep on insisting on a basis of laboratory calculations, I should say that we then better leave them alone. It should not be overlooked that their patent situation seems rather insecure for lack of sufficient disclosure in their claims, so that if somebody also gets out a patent on a specified catalyst, we might find ourselves paying royalties for a process which others can apply without such payments. The chance that this happens should not be neglected for extensive research work on hydrocarbons is going on everywhere. * * *

Yours sincerely,

E. L. MASTHOFF

ELM:MD

DEFENDANT'S EXHIBIT 65

SHELL DEVELOPMENT COMPANY

SIXTH REPORT

PERIOD ENDING DECEMBER 31, 1933

718. GLYCOLS, OXIDES AND RELATED SUBSTANCES (*H. Groll, G. Hearne, C.J. Ott and H. de Jong*).

Purpose.

This investigation was opened during the period under review mainly in order to segregate various activities formerly dealt with under Investigations 717, 1313 and 1314. * * * Also, a limited investigation of the direct formation of ethylene oxide from ethylene and air according to the S.F.C.G. process was undertaken with the aim of checking the patent claims of the French company.

The different subjects are closely related by the character of the products as well as the methods applied and can be subdivided as follows: * * *

(3) Production of ethylene oxide from ethylene and air (S.F.C.G. process).

Programme. * * *

(3) Ethylene and air in the proportions recommended in Dr. Langedijk's report (B.P.M. No. 5205) were passed over a large number of catalysts in an attempt to reproduce the S.F.C.G. process with the data available from the patent specification.

Summary. * * *

(3) Direct Production of Ethylene Oxide from Ethylene and Air—S.F.C.G. Process.

In connection with the discussions in progress between The Hague and the Société Française de Catalyse Généralisée relative to the securing of rights to the latter process for making ethylene oxide by the direct catalytic

oxidation of ethylene, we have carried out experiments to verify the claims of the relevant patents.

It has been extremely difficult to carry out the above programme at Emeryville because the S.F.C.G. refuse any information on the nature of their catalyst. This is, of course, the essential feature of the process.

We were therefore left with the unsatisfactory course of trying as many varieties of catalysts as possible in the time available, being guided in our choice of catalysts by the inadequate disclosures of the S.F.C.G. patents. If this course led to successful results it would at least prove reasonableness in the claims made by the S.F.C.G.; if it led to unsuccessful results it would, however, not disprove the claims but only mean that we had not found such a good catalyst as the S.F.C.G. claim to have. It is axiomatic that the activity of a contact catalyst is dependent upon its history about as much as upon its chemical constitution.

The S.F.C.G. patents, which were our only basis for the investigation, claim the use of a large variety of metals and metal oxides, used either singly or in pairs or larger groups. The metals actually covered by the S.F.C.G. are silver, copper, gold, arsenic, antimony, tin, iron, bismuth, lead, and nickel, whence it will easily be seen that the possible permutations and combinations are enormous, especially if we consider the different forms in which the ingredients may be prepared.

We have tried in our experiments silver turnings, copper turnings, silver activated by amalgamation and heating (known to give a good active silver for dehydrogenations); silver and copper alloyed together by amalgamation and heating; also a complex mixture, as described in the S.F.C.G. American patent application, of antimony, silver, lead, arsenic, nickel, and tin, impregnated on pumice and used in both reduced and unreduced forms; also mixtures containing part of these ingredients in which single elements or pairs were omitted, according to a regular scheme.

In all the experiments with the above catalysts we obtained practically no ethylene oxide at the temperatures recommended by the S.F.C.G. and practically no reaction at all until the temperature was raised to about 500°C.,

at which point a little oxide was obtained but was invariably accompanied by aldehydes, in contradiction to the statements of the S.F.C.G., which claim the exclusive production of ethylene oxide free from aldehydes.

Steam was used in all cases in the preparations as recommended in Dr. Langedijk's report, B.P.M. No. 5205.

In short, we have been unable to get any appreciable oxidation of ethylene with catalysts prepared to the best of our skill and under the guidance of the S.F.C.G. patents and the description of the process as furnished in B.P.M. Report No. 5205. This does not mean that we disagree with the claims made in these patents but only that the disclosures available to us have not enabled us as yet to confirm them. In all the above experiments we started at temperatures around 375°C., as recommended in the B.P.M. report, and after verifying that no reaction occurred there, slowly raised the temperature, still looking for reaction, up to 500°C. It was at this higher temperature, as a rule, that reaction started but with the formation of only traces of ethylene oxide and that accompanied by aldehydes.

In order to determine whether even more powerful though not recommended catalysts were active at 375°C., we tried as an extreme measure the catalyst hopcalite (a mixture of the oxides of the elements copper, cobalt, manganese and silver) in both reduced and unreduced forms.

With this extremely active catalyst in the oxidized form, we obtained oxidation of ethylene below 275°C. This temperature was the highest which could be maintained without the catalyst beginning to glow. The products at all temperatures between 150 and 275°C. were solely CO_2 and H_2O.

After reducing this catalyst with hydrogen at 350°C. it was tried out between 250° and 400°C. At 250°C. the ethylene was not attacked at all, while the oxygen disappeared from the gas due to oxidation of certain constituents of the catalyst. At temperatures toward 400°C. some ethylene was consumed and a corresponding amount of CO_2 formed. No trace of ethylene oxide could be found at any temperature.

Our present position with regard to this investigation is therefore that while ethylene can be oxidized with an extremely active catalyst at temperatures as low as those recommended by the S.F.C.G., only CO_2 and H_2O are formed thereby, and while we may succeed in finding a catalyst of lesser activity which will permit controlled oxidation to ethylene oxide, we have so far been totally unsuccessful in finding it.

Assessment. • • •

(3) The process of the S.F.C.G. for production of ethylene oxide could not be reproduced. It appears therefore that the essential features of this process are not sufficiently disclosed in the patent application of that firm. • • •

UNITED STATES PATENT OFFICE

2,040,782

MANUFACTURE OF OLEFINE OXIDES

Adrianus Johannes van Peski, Amsterdam, Netherlands, assignor to Shell Development Company, San Francisco, Calif., a corporation of Delaware

No Drawing. Application November 5, 1934, Serial No. 751,579. In the Netherlands April 26, 1934

23 Claims. (Cl. 260—54)

This invention relates to a novel process for the manufacture of olefine oxides which comprises reacting an olefine with free oxygen, which oxygen may be present as oxygen per se or in admixture with other gaseous materials as steam, nitrogen, carbon dioxide, etc., said oxidation being effected in the presence of an active catalyst substantially comprising silver metal prepared by effecting the thermal decomposition of an organic silver compound.

An object of my invention is to provide a practical, economical and broadly applicable method for effecting the catalytic oxidation of olefines to the corresponding valuable olefine oxides.

The olefine oxides are valuable compounds per se as solvents, extractants, fumigants and insecticides and the like. In addition, they are valuable intermediates in the preparation of a wide variety of useful organic compounds such as alcohols, glycols, aldehydes, carboxylic acids, ethers, esters, alkylolamines, resins, polymers and the like.

Heretofore no practical method has been proposed for the production of olefine oxides by effecting the direct oxidation of the corresponding olefines. It is known that ethylene may be reacted with oxygen to obtain small amounts of ethylene oxide and large quantities of formaldehyde, and carbon oxides. Various catalysts and methods of controlling the oxidation to increase the yields of ethylene oxide have been proposed.

I have attempted to prepare ethylene oxide in accordance with the disclosed methods. These attempts were unsuccessful. Under optimum conditions of operation, in accordance with the known methods, employing as catalysts silver per se, colloidal silver and silver prepared by effecting the decomposition or reduction of inorganic silver compounds, only traces of ethylene oxide were obtained, while substantially complete oxidation of the ethylene to carbon dioxide occurred. Due to the low yields of ethylene oxide obtained and the substantially complete conversion of the ethylene to carbon dioxide, the known methods of oxidizing ethylene have failed to warrant consideration as practical processes for the technical production of ethylene oxide.

Now I have found that, in the presence of a particularly active catalyst which I prepare by effecting the thermal decomposition of an organic silver compound, I may oxidize an olefine to its corresponding olefine oxide in yields sufficiently high to render my process commercially attractive as a method for the manufacture of olefine oxides.

In the execution of my invention I preferably employ the normally gaseous or readily volatile unsaturated organic compounds such as ethylene, propylene, the butylenes, the amylenes and their homologues and suitable substitution products. I may employ the olefines severally or in mixtures containing a plurality of different species of olefines, or I may resort to the use of mixtures thereof with relatively unreactive substances. For example, mixtures of olefines and paraffins may be employed without resorting to the separation of the olefine or olefines therefrom. Such olefine-containing mixtures may be obtained by the pyrogenesis or cracking of mineral oils such as petroleum oil and shale oil, by the destructive distillation of various kinds of brown coal, by the cracking of natural carbonaceous material as petroleum products, tars, pitches, asphalts and the like.

In addition to the above-described mixtures of olefines with relatively inactive organic compounds, I may employ an olefine or olefines in admixture with inactive gases such as carbon-dioxide, hydrogen, nitrogen, steam and the like.

The successful execution of my invention is dependent on the use of active silver catalytic material which is obtained by effecting the thermal decomposition of suitable organic silver compounds. Suitable organic silver compounds, in general, are those which, on being heated, will decompose with the formation of an active and finely divided silver catalytic material. The silver salts of the carboxylic acids such as formic, acetic, propionic, butyric, isobutyric, valeric, oxalic, malic, molonic, lactic, malaic and the like are particularly suitable organic silver compounds which may be readily decomposed to catalytic silver by heating the same at temperatures at which decomposition can occur. I have found that silver oxalate is a particularly suitable organic silver compound which I may readily decompose with heat to form an active silver catalytic material. Silver oxalate is practically insoluble in water. Accordingly, it may be readily precipitated by the addition of a solution of silver nitrate to a solution of an oxalate. The suitable organic silver compounds may be decomposed in an atmosphere of hydrogen or other suitable reducing gases or decomposition may be effected in the presence of an inert gaseous substance such as nitrogen. In some cases a more efficacious catalytic material may be prepared by dissolving or suspending a suitable organic silver compound in a suitable inert liquid such as petroleum oil, hydrocarbon and the like and the mixture heated to the decomposition temperature of the silver compound in the presence or absence of hydrogen or other reducing gases.

The catalytic effect of the silver catalytic material prepared and used in accordance with my invention may be considerably enhanced by the admixture with the catalytic material of small quantities of other materials capable of acting as promoters. Suitable promoters, which may be used singly or in combination, include the metals such as copper, gold, iron, manganese, nickel, cobalt, cerium, thorium and zinc. I have found that gold and manganese are particularly effective promoters. A suitable promoter or promoters may be incorporated with the mass of silver catalyst in any suitable manner. Preferably, an intimate mixture of the organic compounds of silver and the promoter metal is effected by some suitable means as by precipitation and the same decomposed by heating.

In general, the catalytic material is quite voluminous and in a finely divided state, accordingly, the same may be advantageously employed without resorting to the use of a carrier. However, when desired, the catalytic material may be deposited upon an inert substance or carrier such as pumice, charcoal, activated carbon, silica gel and the like.

My invention is executed by reacting an olefine with free oxygen in the presence of a suitable catalyst as herein described and preferably the same is executed in the presence of a relatively inert gaseous substance which acts as a diluent such as steam, carbon dioxide, nitrogen, a paraffin hydrocarbon and the like. Such a relatively inert gaseous substance may serve primarily as a temperature diluent which serves to obviate local overheating of the catalyst due to "hot spots", to obviate excessive oxidation of the catalyst and to minimize the occurrence of undesirable side reactions resulting in the formation of excessive amounts of carbon dioxide. In general, I prefer to execute my invention in the presence of steam or other relatively inert substances which normally exist in the liquid state, since such diluents are readily separated from the normally gaseous unreacted olefines by condensation.

My process comprises effecting the controlled catalytic oxidation of an olefine to the corresponding olefine oxide by causing said olefine to react with free oxygen, which oxygen may be present as oxygen per se or in admixture with other gaseous materials as steam, nitrogen, carbon dioxide, etc., containing, for example, from 21.0% to 99.9% oxygen, or the free oxygen may be liberated or formed under the conditions of operation from substances containing oxygen in combined form.

The present invention is, in the majority of cases, executed in the vapor phase. When vapor phase methods are employed, the gaseous olefine in admixture with the desired quantity of oxygen per se or oxygen contained in a mixture or solution with other gases as in air is passed preferably continuously over the stationary catalytic material at a predetermined space velocity. In general, one mol. of oxygen reacts with two mols of a mono-olefine to form two mols of the corresponding olefine oxide. I prefer, in the majority of cases, to conduct the reaction in the presence of an excess of olefine over the stoichiometrical amount needed to combine with all of the oxygen present in the reaction space. This excess of olefine may vary within wide limits depending on the activity of the catalyst employed and on the specific operating conditions. Excellent results may usually be obtained by operating so that the reactants enter the reaction chamber in the ratio of one mol. oxygen to about 2.0 to 2.5 mols of mono-olefine. When steam and the like diluents are employed the same may be introduced into the reaction chamber separately or in admixture with the reactants.

The term "space velocity", as used herein, may be defined as the unit volume of olefine flowing through the reaction space per unit volume of catalyst, under standard conditions of temperature and pressure.

My invention is executed in a preferred temperature range of from 200° to 500° C. The use of temperatures below about 200° C. is, in the majority of cases, impractical due to the relatively slow rate of reaction even when exceedingly low space velocities are employed. The practical upper limit of the reaction temperature is set by the occurrence of pyrolytic side reactions at too high a temperature at the existing pressure. The temperature to be chosen for each specific operation is dependent on the activity of the catalyst employed, on the pressure in the reaction chamber, on the space velocity, on the stability and character of the olefine reacted, and also on the stability of the resulting product as regards cracking, polymerization and resistance against further oxidation. When it is desired to employ high space velocities, it may be of advantage to operate at temperatures near the upper limit of the allowable range. If low space velocities are employed, it may be desirable to operate at temperatures near the lower limit of the range.

The reaction of an olefine with free oxygen to form an olefine oxide is in itself endothermic. However, due to the fact that the reaction to form the olefine oxide is usually accompanied by oxidation of the olefine and/or olefine oxide to carbon dioxide, heat will be liberated in the course of the reaction. The temperature of the catalytic mass may be kept substantially constant at the predetermined desired temperature by one or combinations of the suitable methods known to the art. By a proper method of distributing the gas mixture comprising the olefine, oxygen and possibly steam, nitrogen, etc., throughout the catalyst bed, the whole may, once the reaction is initiated, be kept at a uniform temperature without the application of external heat, thus effecting a considerable economy of operation. Furthermore, the space velocity may be adjusted and the heat of reaction thereby controlled, or suitable heat exchangers may be internally or externally applied. The reaction zone may be surrounded by a selected constant boiling substance which on vaporization consumes heat liberated by the reaction and thereby maintains a substantially constant temperature of the reaction zone. To constant boiling substance, if inert, may be directly introduced into the reaction zone, from which it may be recovered and reused. In the execution of my invention, I may employ the heat liberated by the oxidation reaction to preheat, severally or in combination, the gases entering the reaction zone, thus effecting thermal economies.

My process may be executed at subatmospheric, atmospheric or superatmospheric pressure. In general, I prefer to execute the same at pressures slightly in excess of atmospheric, although it can be seen that when operating with olefines which might themselves polymerize or yield readily polymerizable or decomposable reaction products at

the desired reaction temperature, it may be desirable to employ atmospheric or subatmospheric pressures.

The exit vapors from the reaction zone may be passed into a suitable condenser or fractionating column wherein the less volatile olefine oxide, water and other condensable constituents are separated from the unreacted olefine. After separation of the olefine oxide the reaction gases containing unreacted olefine may be mixed with the desired quantity of free oxygen or free oxygen containing gas and again passed over the catalyst to obtain further conversion of the olefine contained therein. The water formed in the reaction zone or introduced therein as steam, is generally liquefied with the olefine oxide, from which it may be separated by any suitable method as fractionation, stratification, use of drying agents, and the like. Any other normally liquid substance formed in the course of the reaction or introduced into the reaction mixture may be separated from the liquid olefine oxide by any suitable method known to the art.

For illustrative purposes only, reference is had to several examples which typify preferred methods of preparing suitable catalytic material and preferred modes and conditions of executing my invention.

Example I

An active finely divided silver catalyst was prepared by heating silver oxalate ($Ag_2C_2O_4$) at a temperature slightly above its decomposition temperature until substantially complete decomposition to metallic silver was effected.

An ethylene-air mixtufe containing from 8% to 9% ethylene was passed over the stationary silver catalytic material contained in a suitable reaction tube and heated to a temperature of about 350° C. The ethylene-air mixture was passed over the catalyst at the rate of about 88 liters per hour (measured at room temperature and atmospheric pressure) while steam was added at the rate of from 100 to 200 gm. per hour. During the run, the reaction temperature was maintained at from about 350° C. to about 400° C.

The exit vapors were condensed and the condensate containing water and ethylene oxide was fractionated for the recovery of the ethylene oxide.

About 10% of the ethylene was converted to ethylene oxide on one passage over the catalyst. The exit gases, after condensation of the ethylene oxide and water, were mixed with the desired quantity of air and again passed through the apparatus for further conversion of the ethylene.

This experiment was repeated using a colloidal silver catalyst and a catalytic silver prepared by reducing, with hydrogen, silver hydroxide precipitated on pumice stone or silica gel. With these catalysts, and employing substantially identical reaction conditions, only traces of ethylene oxide could be detected in the liquid condensate.

Example II

A very efficacious silver catalyst containing a small amount of gold which serves as a promoter was prepared as follows: the compound

$$[Au(NH_3)_4](NO_3)_3$$

was prepared by reacting ammonia and ammonium nitrate with gold chloride. 200 gm. of silver nitrate and 1.6 gm. of $[Au(NH_3)_4](NO_3)_3$ were dissolved in 2 liters of water and this solution was added to a solution of 84 gm. of sodium oxalate in 3 liters of water. The precipitate, which consisted of silver oxalate and the compound $[Au(NH_3)_4](C_2O_4)NO_3$, was successively washed with alcohol and ether and the ether evaporated therefrom by exposure to the air. The precipitate was then decomposed in small portions in a porcelain crucible heated to about 300° C.

A convenient quantity of the catalytic material was placed in a suitable reaction tube inclosed in a reaction furnace and maintained at a temperature of about 350° C. About 88 liters of a gas mixture having the approximate by volume composition: 0.2% CO_2, 7.8% C_2H_4, 19.3% O_2, 72.7% N_2 and about 174 gm. of steam were passed per hour over the catalyst.

About 17.4% of the ethylene present was converted to ethylene oxide on one passage over the catalytic material. Substantially complete conversion of the ethylene to oxide was effected by repeated admixture with oxygen and passage of the mixture over the catalyst.

Example III

About 100 gm. of silver nitrate and about 1.5 gm. of copper nitrate were dissolved in one liter of water and the resulting solution added to a solution of about 41 gm. of sodium oxalate in 1.5 liters of water. The precipitate was washed, dried, decomposed by heating and subsequently brought into a suitable reaction tube.

By using this catalyst and employing substantially the same reaction conditions as described in Example II, about 12% of the ethylene present in the reaction mixture was converted to ethylene oxide on one passage over the catalytic material.

Example IV

About 100 gm. of silver nitrate and about 0.215 gm. of ferric nitrate were dissolved in 1 liter of water and the resulting solution added to a solution of about 42 gm. of silver oxalate in about 1.5 liters of water. The resulting precipitate was separated from the aqueous solution, washed, dried and decomposed by heating.

The resulting catalyst was used under substantially the same conditions as described in Example II. An average conversion of from 12% to 13% of the ethylene to ethylene oxide was effected on one passage of the gas mixture through the reaction zone.

Example V

About 100 gm. of silver nitrate and about 5 gm. of manganese nitrate were dissolved in about 500 cc. of water and the solution was added to a solution of about 42 grams of sodium oxalate in about 1.5 liters of water. The resulting precipitate was washed successively with water, alcohol and ether, then freed of ether by exposure to the air and decomposed in small portions by heating. About 48 gm. of catalytic material having an apparent volume of about 220 cc. were obtained.

A gas mixture having the approximate by volume composition: 0.4% CO_2, 8.4% C_2H_4, 18% O_2 and 73.2% N_2 was treated as follows: the gas mixture was passed over the catalyst at an average rate of about 88 liters per hour, while steam was added at an average rate of about 200 gm. per hour. The catalytic material was maintained at an average temperature of about 350° C.

About 16.9% of the ethylene was converted

to ethylene oxide on one passage through the reaction zone.

My invention provides a batch, intermittent or continuous mode of operation whereby olefines may be substantially completely converted to olefine oxides.

It will be evident to those skilled in the art that the specific operating conditions such as space velocities, pressure, temperature, etc., may be varied within wide limits within the scope of my invention, depending on the relative activity of the catalyst employed, the concentrations of olefine, olefine oxide and free oxygen in the reaction mixture and on the specific olefine oxidized.

While I have in the foregoing described in some detail the preferred embodiments of my invention and some variants thereof, it will be understood that this is only for the purpose of making the invention more clear and that the invention is not to be regarded as limited to the details of operation herein described, nor is it dependent upon the soundness or accuracy of the theories which I have advanced as to the advantageous results obtained. On the other hand, the invention is to be regarded as limited only by the terms of the accompanying claims, in which it is our intension to claim all novelty inherent therein as broadly as possible in view of the prior art.

I claim as my invention:

1. A process for the production of olefine oxides which comprises reacting an olefine with oxygen in the presence of a silver catalyst obtained by effecting the thermal decomposition of silver oxalate, said reaction being effected at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored.

2. A process for the production of olefine oxides which comprises reacting an olefine with oxygen in the presence of an activated catalyst prepared by effecting the thermal decomposition of a silver salt of an aliphatic carboxylic acid, and activated by the addition thereto of a metallic promoter essentially comprising a heavy metal, said reaction being effected at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored.

3. A process for the production of olefine oxides which comprises reacting an olefine with oxygen in the presence of an activated catalyst prepared by effecting the thermal decomposition of a silver salt of an aliphatic carboxylic acid, and activated by the addition thereto of a heavy metal catalyst promoter of the class consisting of copper, gold, nickel, iron, cobalt, manganese, cerium, thorium and zinc, said reaction being effected at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored.

4. A process for the production of olefine oxides which comprises reacting an olefine with oxygen in the presence of an activated catalyst prepared by effecting the thermal decomposition of an intimate mixture of a silver salt of an aliphatic carboxylic acid with a small amount of a gold compound, said reaction being effected at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored.

5. A process for the production of olefine oxides which comprises reacting an olefine with less than the stoichiometrical amount of free oxygen in the presence of a catalyst essentially comprising silver metal obtained by effecting the thermal decomposition of a silver salt of an aliphatic carboxylic acid, said reaction being effected at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored.

6. A process for the production of olefine oxides which comprises reacting an olefine with oxygen in the presence of a relatively inert gas, said reaction being effected in the presence of a catalyst essentially comprising silver metal obtained by effecting the thermal decomposition of a silver salt of an aliphatic carboxylic acid, said reaction being effected at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored.

7. A process for the production of olefine oxides which comprises reacting an olefine with oxygen in the presence of steam, said reaction being effected in the presence of a catalyst essentially comprising silver metal obtained by effecting the thermal decomposition of a silver salt of an aliphatic carboxylic acid, said reaction being effected at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored.

8. A process for the production of olefine oxides which comprises reacting an olefine with oxygen at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored in the presence of a catalyst essentially comprising silver metal obtained by effecting the thermal decomposition of a silver salt of an aliphatic carboxylic acid.

9. A process for the production of olefine oxides which comprises reacting an olefine with oxygen at temperatures between 200° C. and 500° C. in the presence of a catalyst essentially comprising silver metal obtained by effecting the thermal decomposition of a silver salt of an aliphatic carboxylic acid.

10. A process for the production of olefine oxides which comprises reacting an olefine with oxygen in the molal ratio of at least two mols of olefine to one mol. of oxygen, in the presence of steam, at a temperature in the range of from 200° C. to 500° C. and in the presence of a catalyst essentially comprising silver metal obtained by effecting the thermal decomposition of a silver salt of an aliphatic carboxylic acid.

11. A process for the production of olefine oxides by catalytically oxidizing olefines which comprises passing an olefine-air mixture at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored over a silver catalyst prepared by effecting the thermal decomposition of a silver salt of an aliphatic carboxylic acid.

12. A process for the production of olefine oxides by catalytically oxidizing olefines which comprises passing an olefine-air mixture containing olefine and oxygen in the ratio of at least two mols of olefine to one mol. of oxygen, in the presence of steam and at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored, over a catalyst mass comprising silver metal obtained by effecting the ther-

mal decomposition of a silver salt of an aliphatic carboxylic acid.

13. A process for the production of ethylene oxide which comprises reacting ethylene with oxygen in the presence of a silver catalyst prepared by effecting the thermal decomposition of a silver salt of an aliphatic carboxylic acid, said reaction being effected at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored.

14. A process for the production of ethylene oxide which comprises reacting ethylene with oxygen in the presence of steam at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored and in the presence of a silver catalyst prepared by effecting the thermal decomposition of a silver salt of an aliphatic carboxylic acid.

15. A process for the production of ethylene oxide which comprises reacting ethylene with oxygen in the presence of a silver catalyst obtained by effecting the thermal decomposition of silver oxalate, said reaction being effected at a temperature not substantially less than 200° C but below the temperature at which pyrolytic side reactions are substantially favored.

16. A process for the production of ethylene oxide which comprises reacting ethylene with oxygen in the presence of steam at a temperature in the range of from 200° C. to 500° C. and in the presence of a silver catalyst essentially comprising silver metal prepared by effecting the thermal decomposition of silver oxalate.

17. A process for the production of ethylene oxide by catalytically oxidizing ethylene which comprises passing an ethylene-air mixture containing ethylene and oxygen in the molal ratio of at least two mols of ethylene to one mol. of oxygen, in the presence of steam and at a temperature in the range of from 200° C. to 500° C., over a catalyst mass essentially comprising silver metal obtained by effecting the thermal decomposition of silver oxalate.

18. A process for the production of ethylene oxide which comprises reacting ethylene with oxygen in the presence of steam at a temperature in the range of from 200° C. to 500° C. and in the presence of an activated catalyst prepared by effecting the thermal decomposition of silver oxalate and activated by the addition thereto of a heavy metal catalyst promoter of the class consisting of copper, gold, nickel, iron, cobalt, manganese, cerium, thorium and zinc.

19. A process for the production of an olefine oxide which comprises reacting an olefine with oxygen in the presence of a silver metal catalyst obtained by effecting the thermal decomposition of a silver salt of an aliphatic carboxylic acid, said reaction being effected at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored.

20. A process for the production of an olefine oxide which comprises reacting an olefine with oxygen in the presence of a relatively inert diluent material and in the presence of a silver metal catalyst obtained by effecting the thermal decomposition of a silver salt of an aliphatic carboxylic acid, said reaction being effected at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored.

21. A process for the production of an olefine oxide which comprises contacting an olefine with less than a stoichiometrical amount of free oxygen and subjecting the mixture to a treatment, in the presence of a silver metal catalyst obtained by thermal decomposition of a silver salt of an aliphatic carboxylic acid, at a temperature of from about 200° C. to about 500° C.

22. A process for the production of ethylene oxide which comprises reacting ethylene with oxygen in the presence of steam at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored, said reaction being catalyzed by the presence of an active catalyst prepared by effecting the thermal decomposition of an intimate mixture of a silver salt of an aliphatic carboxylic acid with a relatively smaller amount of a gold compound.

23. A process for the production of ethylene oxide which comprises reacting ethylene with oxygen in the presence of steam at a temperature not substantially less than 200° C. but below the temperature at which pyrolytic side reactions are substantially favored, said reaction being catalyzed by the presence of an active catalyst prepared by effecting the thermal decomposition of an intimate mixture of a silver salt of an aliphatic carboxylic acid with a relatively smaller amount of a manganese compound.

ADRIANUS JOHANNES VAN PESKI.

PATENT SPECIFICATION

402,438

Convention Date (France): Oct. 3, 1931.

Application Date (In United Kingdom): May 2, 1932. No. 12,561/32.

Complete Accepted: Dec. 4, 1933.

COMPLETE SPECIFICATION.

Improvements in or relating to the Production of Ethylene Oxide, particularly for the Preparation of Ethylene-glycol and of its Derivatives.

We, SOCIETE FRANCAISE DE CATALYSE GENERALISEE, a Joint-stock company duly organised according to French Laws, of 8, Avenue-Percier, Paris, France, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to the preparation of ethylene oxide. It is known that ethylene may be converted into aldehydes, more particularly formaldehyde, by oxidation. The conversion of ethylene into ethylene oxide, however, has heretofore offered considerable difficulties. In fact, the separation of the aldehydes and the ethylene oxide constitutes a complicated operation which hitherto has not permitted the industrial preparation of ethylene oxide by the direct oxidation of ethylene. With the process according to the invention, ethylene oxide and carbon dioxide are obtained without aldehydes except in the form of traces.

The present invention comprises subjecting the ethylene to the simultaneous action of the oxygen of the air and water in the presence of a catalyst constituted by the following metals and their oxides, alone or in admixture; namely antimony, lead, bismuth, silver, arsenic, nickel, tin, gold, copper, iron.

It has been found that hydrogen, when introduced into the reaction, assists the latter.

Hydrogen probably plays the part of an agent for accelerating the base reaction of the process which can be written as follows:—

$$2\ \begin{matrix} H_2C \\ \| \\ H_2C \end{matrix} + O_2 \longrightarrow 2\ \begin{matrix} H_2C \\ \| \\ H_2C \end{matrix}\!\!>\!O$$

This reaction takes place at atmospheric pressure, but for commercially carrying the said process into practice, pressure can be employed, for instance a pressure of 50 kilograms per square centimeter, at a temperature between 150 and 400° C.

The following catalysts may be used:—

1.) a mixture of antimony, bismuth, silver, lead, arsenic, nickel and tin in variable proportions;

2.) silver alone,
bismuth alone,
antimony alone,

3.) mixtures of antimony, lead, nickel and silver,

4.) mixtures of bismuth, nickel, silver and lead,

5.) mixtures of antimony, bismuth, nickel,

6.) mixtures of antimony, bismuth, silver,

7.) mixtures of bismuth and nickel,

8.) mixtures of bismuth and silver.

And, generally speaking one or mixtures of the following metals: antimony, lead, bismuth, silver, nickel, tin, arsenic, gold, copper, iron, taken two by two, three by three, four by four, etc. . . in variable proportions, the mixtures, in the same conditions, of these metals with their oxides, the mixtures of the oxides alone of these metals, in the same conditions.

The ethylene can be obtained from any source of supply: gas from coke ovens, hydrogenation of acetylene, dehydration of ethyl alcohol, and the like.

Water can be admitted in the reaction vessel, either in the liquid state, or as steam.

The oxygen can be the oxygen of the air, this latter gas being introduced in the reaction.

Several modi operandi for carrying the process into practice, will be indicated hereinafter, by way of example only.

MODUS OPERANDI I.—

In a plant constructed for resisting high pressures, ethylene on the one hand, and air on the other hand, are separately compressed by means of suitable compressors.

The mixture of air and ethylene can also be compressed by taking the necessary precautions in order to avoid the risk of explosion.

These two gases will be led, together with hydrogen or not, into a reaction tube

[Price 1/-]

resisting the pressure of several hundreds of kilograms, containing one of the catalysers indicated above, and heated, for instance, to a temperature of 200° C. This tube communicates moreover with a circulating pump allowing to introduce water under pressure.

The reaction will take place in this tube between ethylene, the oxygen of air, and water. By controlling the outputs, a continuous operation will be obtained. Ethylene oxide thus formed will be separated from the other gases, for instance, by condensation.

Modus Operandi II.—

Silver in powder form, or in the form of a wire gauze, and placed or not on a support or carrier, is introduced in a tube, made for instance of silica, and, after the said tube has been heated to a temperature comprised between 150 and 400° C., a mixture of ethylene, air, water vapour, and hydrogen is caused to pass therethrough. The proportion of hydrogen is about 5% of the total mixture. The ethylene oxide produced can be separated from the gases issuing from the tube.

Modus Operandi III.—

Colloidal silver is introduced in a high pressure tube which has been partly filled with water. Pure ethylene under pressure is then added in order that it can dissolve in the water.

The tube is subsequently heated between 150° and 400° C., then air and hydrogen are slowly introduced. The introduction of air is stopped when the totality of ethylene is converted into ethylene oxide.

From ethylene oxide produced according to the processes which have been indicated above, it is possible to obtain by simple saponification, ethylene-glycol, or by other known methods any derivative of ethylene-glycol.

The reaction, for obtaining ethylene-glycol can be written as follows:

$$C_2H_4O + H_2O \longrightarrow \begin{matrix} H_2C{-}OH \\ | \\ H_2C{-}OH \end{matrix}$$

The experiments effected by the applicant have shown that, in presence of the catalysers indicated, water, in the form of steam or not, considerably promotes the reaction ensuring the production of ethylene oxide.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A process of obtaining ethylene oxide consisting in subjecting ethylene to the simultaneous action of the oxygen of the air and water, in the presence of a catalyst constituted by the following metals and their oxides, alone or in admixture: namely antimony, lead, bismuth, silver, arsenic, nickel, tin, gold, copper, iron.

2. A process for the production of ethylene oxide, which consists in subjecting ethylene to the simultaneous action of oxygen and water, in the presence of a catalyst, constituted by a mixture of antimony, bismuth, silver, lead, arsenic, nickel and tin, at a temperature between 150 and 400° C.

3. A process for the production of ethylene oxide as claimed in claims 1 and 2, characterised by the fact that a mixture of ethylene, air, water vapour and hydrogen is caused to pass in a tube, made of refractory material, containing the catalyst and heated to a temperature comprised between 150 and 400° C.

4. A process for the production of ethylene oxide as claimed in claim 3, characterised by the fact that the proportion of hydrogen is about 5% of the total volume of the gases in presence.

5. The process for the production of ethylene oxide, particularly for the preparation of ethylene-glycol and of its derivatives, substantially as hereinbefore described.

Dated this 2nd day of May, 1932.

SOCIETÉ FRANCAISE DE CATALYSE GENERALISEE,
Per Boult, Wade & Tennant,
111 & 112, Hatton Garden, London, E.C. 1,
Chartered Patent Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1933.

Defendant's Exhibit 73

PATENT SPECIFICATION

Convention Date (France): Dec. 19, 1931.

402,749

Application Date (In United Kingdom): May 2, 1932. No. 12,579/32.

(Patent of Addition to No. 402,438. Convention Date (France): Oct. 3, 1931.)

Complete Accepted: Dec. 4, 1933.

COMPLETE SPECIFICATION.

Improvements in or relating to the Production of Ethylene Oxide, particularly for the Preparation of Ethylene-glycol and of its Derivatives.

We, SOCIETE FRANCAISE DE CATALYSE GENERALISEE, a Joint-Stock Company duly organised according to French Laws, of 8, Avenue Percier, Paris, France, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The process described in the main British patent for "Process for the production of ethylene oxide, particularly for the preparation of ethylene-glycol and of its derivatives", dated 2nd May, 1932, No. 12,561/32 (Serial No. 402,438) mainly consists in subjecting ethylene to the simultaneous action of oxygen and water in presence of a catalyst and if desired of hydrogen.

In the examples described in the main patent for carrying this process into practice, the reaction takes place at a pressure equal to or greater than atmospheric pressure, in presence of catalysts among which is cited silver in the colloidal form, or in the form of a powder or of a gauze.

Experiments have shown that silver could be considerably activated by introducing, into this body, small quantities of gold, copper and iron.

According to the invention, therefore, a process for the production of ethylene oxide consists in subjecting ethylene to the simultaneous action of oxygen and water in the presence of a catalyst constituted by silver containing small quantities either of gold, or of copper, or of iron, at a temperature between 150 and 400° C.

Thus, a mixture containing silver, gold, copper and iron, gives very satisfactory results when used as a catalyst and allows a specific reaction; the only foreign product obtained in the reaction is CO_2, which can be easily removed. Aldehydes formed exist only as traces.

The applicant has also found that the reaction giving CO_2 is, contrary to previous belief, a reaction of oxidation independent from that giving ethylene oxide and from that giving aldehydes. From experiments effected by the applicant, it results that, if water is introduced in suitable quantity, the reaction is not only facilitated, as indicated in the main Patent, but, in addition, the reaction giving CO_2, probably by direct oxidation of ethylene according to the equation:

$$C_2H_4 + 3O_2 + 2H_2O + 2CO_2$$

is checked, owing, as is probable, to the partial pressure of water. From these experiments, it can be concluded that if a certain quantity of CO_2 is previously introduced, in addition, in the reacting gases, the partial pressure of CO_2 will produce its effect and the reaction of oxidation of ethylene into CO_2 will be completely checked resulting in a considerable increase in the efficiency of the operation. Moreover, it is to be noted that, when the synthetic operation is effected under partial vacuum, the yield in ethylene oxide is increased.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water in the presence of a catalyst constituted by silver containing small quantities either of gold, or of copper, or of iron, at a temperature between 150 and 400° C.

2. A process for the production of ethylene oxide as claimed in Claim 1, in which there is added to the gases present, hydrogen in the proportion of 5% of the total volume of the said gases.

3. A process for the production of ethylene oxide as claimed in Claims 1 and 2, in which carbon dioxide gas is added to the gases present.

84. [Price 1/-]

Defendant's Exhibit 73 (continued)

4. A process for the production of ethylene oxide as claimed in Claim 1 and either of Claims 2 and 3, in which the reaction takes place at a pressure lower than atmospheric pressure.

Dated this 2nd day of May, 1932.

SOCIETE FRANCAISE DE CATALYSE GENERALISEE,
Per Boult, Wade & Tennant,
111 & 112, Hatton Garden, London, E.C. 1,
Chartered Patent Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1933.

PATENT SPECIFICATION

Convention Date (France): July 10, 1933. 431,966

Application Date (In United Kingdom): July 9, 1934. No. 20089/34.

Complete Specification Accepted: July 18, 1935.

COMPLETE SPECIFICATION

Improvements in or relating to the Manufacture of Ethylene Oxide

We, SOCIETE FRANCAISE DE CATALYSE GENERALISEE, a Joint Stock Company duly organised under the French Laws, of 26 rue Pierre-Lhomme, Courbevoie (Seine) France, Manufacturers, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to the production of ethylene oxide by the catalytic oxidation of ethylene with oxygen or an oxygen-containing gas such as air.

This direct oxidation of ethylene requires special precautions owing to the danger of explosion. It has already been proposed to introduce water into the reacting mixture when carrying out the reaction on an industrial scale. Although this avoided the danger of explosions the products of the reaction were aldehydes and not ethylene oxide.

Another proposal has been to effect the catalytic oxidation of ethylene by treating ethylene with oxygen of the air and water and, in some cases, to add hydrogen to the reacting mixture. Since air was to be used there would be an appreciable amount of inactive gas, namely nitrogen, present in the reacting mixture.

A further proposal has been to effect the catalytic oxidation of ethylene by means of oxygen and water in the presence of carbon dioxide.

The advantageous action of carbon dioxide was stated to be explained by the following consideration:—

In addition to the oxidation yielding ethylene oxide, carbon dioxide is formed to some extent according to the equation

$$C_2H_4 + 3O_2 = 2CO_2 + 2H_2O$$

The reaction in this direction would appear to be suppressed or limited by the partial pressure of the carbon dioxide present in the reacting mixture and consequently the yield of ethylene oxide produced according to the equation

$$2C_2H_4 + O_2 = 2C_2H_4O$$

is increased by adding carbon dioxide to the reacting mixture.

The present invention is based on the discovery that an inert gas can be used to replace water as a diluent in the catalytic oxidation of ethylene and is therefore differentiated from the previous proposals by the use of a substantially dry reacting mixture.

A proposal has previously been made to oxidise olefines directly with air but only in vessels having a large volume ratio to ensure a homogeneous gas reaction as distinct from a heterogeneous or catalytic reaction.

Thus, according to the present invention, ethylene oxide is produced by the catalytic oxidation of ethylene in the presence of an inert gas and in the absence of water.

The addition of an inert gas to the reacting mixture as the only diluent has been found to have the same action as water in preventing explosion and has the further advantage that the reaction can be effected under increased pressure. When using water vapour and increased pressures up to fifty atmospheres it is impossible to maintain the water in the state of vapour unless undesirable high temperatures are employed.

Carbon dioxide is preferably used as the inert diluent and this has the additional advantage of inhibiting the undesirable oxidation of ethylene to carbon dioxide and water as indicated above.

A further advantage of substituting an inert gas for water is that the lower specific heat of such gas results in a considerable saving of heat in carrying out the reaction.

The following examples illustrate the manner in which the invention may be carried into effect.

EXAMPLE 1.

A gaseous mixture is prepared containing 66% carbon dioxide, 3, 4% ethylene and 30, 3% air and is passed by any suitable means e.g. by pumping from a gasholder to a catalyst chamber heated to a temperature between 300 and 400°C. Catalyst chamber is packed with a catalyst which may be pure silver or silver activated by the presence of small amounts of gold or copper or of both metals.

We have found that these catalysts namely silver alone, silver and gold, silver and copper or silver, gold and copper together are the most suitable for the production of ethylene oxide. After

passing over the catalyst the gases are treated to recover the ethylene oxide which has been produced. For example the oxide of ethylene may be absorbed by active carbon, or dissolved in water under normal or increased pressure or by any other known means. The carbon dioxide may be recovered by liquefaction and in this manner easily separated from the nitrogen. By a suitable regulation of the length of the catalyst layer and of the speed of passage of the reacting gases, the whole of the ethylene present and the whole of the oxygen can be caused to react. After liquefaction of the carbon dioxide the residual nitrogen can be used in any convenient manner, e.g. for the synthesis of ammonia. With a catalyst tube 23 millemeters in diameter and 60 centimeters length packed with catalyst we have found that the speed of passage of the gaseous mixture may vary between 85 and 250 litres per hour.

EXAMPLE 2.

The same gaseous mixture as described in example 1 is sent by means of a compressor to a steel tube capable of withstanding high pressure and heated electrically. Pressures up to 50 atmospheres may be employed. The heated tube is charged with one of the catalysts indicated hereinbefore. Temperature within the limits indicated in example 1 may be varied according to the pressure employed. The rate of gas flow may lie between 85 and 300 litres per hour.

The use of increased pressure favours the reaction giving rise to ethylene oxide since this reaction is effected with a resulting decrease in volume as can be seen from the equation

$$2\,C_2H_4 + O_2 = 2\,C_2H_4O$$

on the other hand the reaction giving rise to carbon dioxide and water is independent of the pressure, under those conditions of temperature and pressure in which the water is in the form of vapour. The presence of a large excess of carbon dioxide in the reacting gases becomes of greater importance when the synthesis is effected under pressure owing to the partial pressure of this carbon dioxide. The treatment of the products of reaction may be effected as described in the first example given.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. The method of producing ethylene oxide by the catalytic oxidation of ethylene in the presence of an inert gas and in the absence of water.

2. Method according to claim 1 in which the inert gas is carbon dioxide.

3. Method according to claim 1 in which the catalyst consists of or comprises silver with the addition of gold and/or copper.

4. Method according to claim 1 in which the oxidation is carried out under increased pressure.

5. Method according to claim 1 in which the oxidation is effected at temperatures between 300 and 400°C.

6. Method according to claim 1 in which the proportion of inert gas is at least 50% of the total amount of the reacting gases.

7. Ethylene oxide whenever produced by the process of any of the preceding claims or by its obvious chemical equivalent.

Dated this 9th day of July, 1934.

For Societe Francaise de Catalyse Generalisee,
STEVENS, LANGNER, PARRY & ROLLINSON,
Chartered Patent Agents,
5-9, Quality Court, Chancery Lane,
London, W.C.2, and at
17, John Street, New York, U.S.A.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1935.

DEFENDANT'S EXHIBIT 76

FRENCH REPUBLIC
MINISTRY OF COMMERCE AND INDUSTRY
DEPARTMENT OF INDUSTRIAL PROPERTY

Patent of Invention

Group 14— Class 1 No: 771,650

PROCESS FOR OBTAINING ETHYLENE OXIDE BY THE DIRECT OXIDATION OF ETHYLENE.

Societe Anonyme:

SOCIETE FRANCAISE DE CATALYSE GENERALISEE

Residing in France (Seine)

Filed July 10, 1933, at 4:36 p.m. in Paris

Granted July 30, 1934—Published Oct. 13, 1934.

(Patent of invention the grant of which has been deferred in accordance with article 11, paragraph 7 of the law of July 5, 1844, as amended by the law of April 7, 1902.)

The present invention relates to the preparation of ethylene oxide by the direct oxidation of ethylene in contact with pure oxygen or air.

The reaction, or direct oxidation, requires special precautions against explosion hazards. In connection with the industrial oxidation of ethylene it was suggested, as early as 1904, that water vapor be introduced into the reaction. The explosion hazards are thus caused to disappear but the oxidation products have always been aldehydes.

The applicant has improved this process by bringing into play catalysts suitable for obtaining a specific reaction which gives ethylene oxide as the oxidation product. The thus improved process marks a considerable step forward in the technique of the production of ethylene oxide by the direct oxidation of ethylene, but the necessity

of vaporizing large amounts of water requires an expenditure of calories which obviously contributes its share to the production cost of the ethylene oxide obtained.

The present invention remedies this drawback. It has as its object a process for preparing ethylene oxide by the direct oxidation of ethylene without water vapor and with no explosion hazards.

This process is characterized principally in that the ethylene-oxygen or ethylene-air mixture is diluted with a large amount of an inert gas.

In one particularly advantageous form of application of the process defined above as to its general characteristics, the inert gas used is carbon dioxide.

The utilization of CO_2 as an inert gas leads in fact to an important industrial result which it seems should be explained as follows:

In addition to the oxidation of the ethylene, CO_2 is formed which can be considered as the ultimate limit of the oxidation reaction. This total oxidation is graphically represented as follows:

$$C_2H_4 + 3O_2 = 2CO_2 + 2H_2O$$

This reaction is reduced or limited by the partial pressure of the CO_2 present in a large proportion in the active mixture. The yield of the oxidation reaction giving the ethylene oxide is thus improved.

Moreover, the step of introducing CO_2 initially into the gaseous mixture has the considerable advantage of rendering said mixture non-explosive under the conditions in which the synthesis is brought about.

Finally, the substitution of CO_2 for water in the form of vapor enables one readily to effect the synthesis of ethylene oxide under pressure. With water, it is very difficult to superheat at the reaction temperature so as to have water present in the form of vapor notwithstanding the pressure used (from 0 to 50 kilograms per sq. cm.).

By way of example merely there will be described below two methods of operation for carrying the invention into practice:

First method of operation (under atmospheric pressure).

A mixture is made up containing for example 66% CO_2, 3.4% ethylene, 6.3% oxygen, and 24% nitrogen (mixture air + ethylene + CO_2).

This mixture, stored in a gas tank, is passed through the medium of a pump into a synthesis tube heated electrically for example and containing a catalyst. The reaction temperature is between 300 and 400° C. The catalyst used is pure silver, or silver activated either by small amounts of gold or copper or by both gold and copper.

The four catalysts which at present appear to be the most appropriate ones, are:

1) Pure Ag
2) Ag + Au
3) Ag + Cu
4) Ag + Au + Cu.

After their passage through the synthesis tube containing one of the aforementioned catalysts, the gases are passed into a device which enables one to recover the ethylene oxide formed.

These means may either be activated carbon which absorbs the ethylene oxide, or water, whether under pressure or not, which dissolves the ethylene oxide formed, or any other means. The CO_2 which has served can be readily recovered, as for example by liquefaction, whereby it can be readily separated from the nitrogen. In fact, by suitably regulating the length of the catalyst contained in the synthesis tube, and the velocity of the gaseous reactants, all the ethylene and all the oxygen can be made to disappear. After the liquefaction of the CO_2 there thus remains pure nitrogen which can be used, for example in the synthesis of ammonia.

In tests conducted by the applicant the velocity of the gaseous mixture varied between 85 and 250 liters per

hour for a catalytic distance of 60 cm. The synthesis tube was 23 mm. in diameter, and the reaction temperature was about 375° C.

Second method of operation. (Under pressure). One makes up, for example, the same mixture as is described in the first method of operation. This mixture is then delivered by means of a compressor into a steel tube capable of resisting the pressure and heated, for example, electrically. The pressure used may vary between 0 and 50 kg. per sq. cm.

The heated steel tube contains a catalyst selected from among the four specified above.

The temperature used varies within the limits specified above, these variations corresponding to the pressure used and to the rate of gas flow which ranges between 85 and 300 liters per hour.

It is to be noted that pressure promotes the reaction yielding the ethylene oxide. In fact, it will be seen that this reaction

$$2C_2H_4 + O_2 = 2C_2H_4O$$

takes place with contraction of volume, whereas the total oxidation reaction yielding CO_2 and water according to

$$C_2H_4 + 3O_2 = 2CO_2 + 2H_2O$$

is independent of the pressure under the pressure conditions under which the water is in the form of a vapor at the reaction temperature. Moreover, the large excess of CO_2 will assume an even greater importance in the case of the pressure owing to its partial pressure.

The ethylene oxide formed is recovered, as stated above, either by water in order to dissolve it, or by activated carbon in order to absorb it, or by any other means.

One can likewise recover the CO_2 and at the end of the operation obtain pure nitrogen utilizable for all synthesis.

Resumé

The invention has for its object a process for obtaining ethylene oxide by the direct oxidation of ethylene by

means of pure oxygen or air, characterized principally in that the ethylene-oxygen or ethylene-air mixture is diluted with a large proportion of an inert gas.

Methods of carrying the invention into practice are characterized in that:

a) The inert gas used is nitrogen;

b) The inert gas is carbon dioxide which owing to its partial pressure limits the harmful reaction yielding CO_2 and water.

c) The oxidation reaction takes place in the presence of a catalyst constituted by pure silver, silver activated by small amounts of gold or copper, or both gold and copper.

d) The reaction takes place under atmospheric pressure;

e) The reaction takes place under a pressure which may reach 50 kg. per sq. cm.

Societe Anonyme: SOCIETE FRANCAISE DE CATALYSE GENERALISEE

By Power of Attorney
ELLUIN AND BARNAY.

DEFENDANT'S EXHIBIT 78

Liber B168 page 547

ASSIGNMENT

WHEREAS, SOCIETE FRANCAISE DE CATALYSE GENERALISEE, a French limited company having an office at No. 26 rue Pierre Lhomme, Courbevoie, France, is the sole and exclusive owner of Letters Patent of the United States No. 1,998,878 issued April 23, 1935, and entitled "Processes for the Production of Ethylene Oxide", and Application for Letters Patent

of the United States No. 39,196, entitled "Improvements relative to the Production of Olefine Oxide and of Catalysts for Use in such Production"; and

WHEREAS, CARBIDE AND CARBON CHEMICALS CORPORATION, a corporation organized and existing under the laws of the State of New York, having an office at No. 30 East 42nd Street, in the City and State of New York, United States of America, is desirous of acquiring the entire right, title and interest in and to and under the said Letters Patent and Application for Letters Patent and the inventions covered thereby, and any and all improvements at any time made thereon:

NOW, THEREFORE, TO WHOM IT MAY CONCERN, be it known that for and in consideration of the sum of One Dollar ($1.00) to it in hand paid by said CARBIDE AND CARBON CHEMICALS CORPORATION, and other good and valuable considerations, the receipt of which is hereby acknowledged, said SOCIETE FRANCAISE DE CATALYSE GENERALISEE has sold, assigned, transferred and set over and does hereby sell, assign, transfer and set over to said CARBIDE AND CARBON CHEMICALS CORPORATION, its successors, assigns and other legal representatives, the entire right, title and interest in and to said Letters Patent and said Application for Letters Patent and the inventions therein disclosed, described or claimed, and in and to any and all improvements at any time made thereon, and in and to any and all Letters Patent of the United States which may be granted (if any) thereon, and all reissue or reissues, division or divisions, or extension or extensions of any such Letters Patent, the same to be held and enjoyed by the said CARBIDE AND CARBON CHEMICALS CORPORATION for its own use and behoof and for the use and behoof of its successors, assigns or other legal representatives, to the end of the term or terms for which said Letters Patent may be granted, reissued, divided or extended, as fully and entirely as the same would have been held and enjoyed by said SOCIETE FRANCAISE DE CATALYSE GENERALISEE if this assignment and sale had not been made, together with all claims for damages by reason of past infringement of said Letters Patent with

the right to sue for and collect the same for its own use and behoof and for the use and behoof of its successors, assigns or other legal representatives.

And said SOCIETE FRANCAISE DE CATALYSE GENERALISEE hereby authorizes and requests the Commissioner of Patents to issue any and all Letters Patent of the United States under said invention or improvements or resulting from said Application or any divisions thereof to said CARBIDE AND CARBON CHEMICALS CORPORATION as Assignee of the entire interest.

And said SOCIETE FRANCAISE DE CATALYSE GENERALISEE further covenants and agrees that it will at any time upon request execute and deliver any and all papers that may be necessary or desirable to perfect the title to said invention or improvements thereon, or any Letters Patent that may be granted therefor, in CARBIDE AND CARBON CHEMICALS CORPORATION, its successors, assigns or other legal representatives, and that if the said CARBIDE AND CARBON CHEMICALS CORPORATION, its successors, assigns or other legal representatives, desires to secure a reissue, division or extension of said Letters Patent it will, upon request, sign all papers, make all rightful oaths and do all legal acts necessary and requisite for the application of such reissue, division or extension and the procuring thereof, but at the expense of CARBIDE AND CARBON CHEMICALS CORPORATION, its successors, assigns or other legal representatives, and said SOCIETE FRANCAISE DE CATALYSE GENERALISEE hereby covenants that it has full right to convey the entire interest herein assigned and covenants and agrees that it will at any time, upon request, communicate to the said CARBIDE AND CARBON CHEMICALS CORPORATION, its successors, assigns or other legal representatives, any facts relating to the said invention or improvements thereon and Letters Patent or to the history thereof known to it, and will cause testimony to be given as to the same in any interference or litigation when requested so to do.

IN WITNESS WHEREOF SOCIETE FRANCAISE DE CATALYSE GENERALISEE has caused these presents to be executed by its Administrator thereunto

duly authorized and its Corporate Seal to be hereto affixed and attested this 18th day of August 1936.

SOCIETE FRANCAISE DE
CATALYSE GENERALISEE

By JACQUES FRANCON
Administrateur Directeur

(Rubber stamp)

Societe Francaise
De Catalyse Generalisee
26 Rue Pierre-Lhomme
Courbevoie (Seine)

Attest:

LUCIENNE BOUVERET

REPUBLIC OF FRANCE
CITY OF LYON
CONSULATE OF THE UNITED
STATES OF AMERICA } ss:

On this 18th day of August 1936, before me personally appeared Jacques Francon to me personally known and known to me to be the Administrator of Societe Francaise De Catalyse Generalisee, the company which executed the foregoing Assignment, and being by me duly sworn did acknowledge to me that he executed the same on behalf of Societe Francaise De Catalyse Generalisee for the purpose therein set forth, being thereunto duly authorized.

Aug 18, 1936
Stamp

GEO. P. WILSON

Vice Consul of the United States of America
LYON FRANCE

RECORDED
Transfers of Patents
U.S. Patent Office
Sept. 16, 1936
Liber B168, page 547
Conway P. Coe, Commissioner of Patents

Defendant's Exhibit 80

have similar effects in the polymorphic and stability relations of compounds with a common anion.

7. Binary crystals increase in hardness as the ionic potentials of their constituents increase.

BALTIMORE, MARYLAND

[CONTRIBUTION FROM THE SCHOOL OF CHEMISTRY OF THE UNIVERSITY OF MINNESOTA]

THE CATALYTIC ACTIVITY OF METALLIZED SILICA GELS. V. THE OXIDATION OF ETHYLENE[1]

BY L. H. REYERSON AND L. E. SWEARINGEN

RECEIVED MAY 31, 1928 PUBLISHED NOVEMBER 6, 1928

Previous investigations of the authors[2] have shown that metallized silica gels exhibit considerable activity in certain oxidation reactions. The following investigation is an extension of this work to the oxidation of ethylene. Willstätter and Bommer[3] in their quantitative study of the conditions for the formation of formaldehyde from ethylene showed that, unless dilute, both ethylene and formaldehyde are unstable at temperatures much above 300°. They found that the use of catalysts accelerated the oxidation of ethylene but no formaldehyde was detected when catalysts were used. An osmium catalyst was found to initiate the oxidation of ethylene at about 130°, while copper proved to be effective at 250°. Blair and Wheeler[4] continued these investigations and found that, with a platinum catalyst, formaldehyde was formed at 405° when the gases were streamed through the catalyst very rapidly. As a result of these investigations, it was hoped that the use of metallized silica gels as catalysts would so lower the temperature at which reaction occurred that partial oxidation of ethylene could be effected and a mechanism for its catalytic oxidation obtained.

The experimental procedure was similar to that used by the authors in the study of the oxidation of methane.[5] Samples of the same catalysts were used as in the preceding investigations. Mixtures of ethylene, oxygen and nitrogen were passed over the catalysts at temperatures ranging from about 100 to 310° at varying rates of flow. In no case did the sum of oxygen and ethylene in the mixture exceed 50% of the gas volume. Preliminary experiments showed that the products of oxidation were carbon dioxide and water, so that the gases after passing through the catalyst were analyzed for ethylene, oxygen and carbon dioxide. In no case did tests show the presence of intermediate products of oxidation.

[1] In memory of Ira Remsen.

[2] Swearingen and Reyerson, *J. Phys. Chem.*, 32, 113, 192 (1928).

[3] Willstätter and Bommer, *Ann.*, 422, 36 (1921).

[4] Blair and Wheeler, *J. Soc. Chem. Ind.*, 41, 303T (1922).

[5] *Ref.* 2, p. 192.

Defendant's Exhibit 80 (continued)

Experimental Results

The results of the experiments are given in Tables I to IV and Figs. 1 and 2 graphically represent typical experiments. The symbols used in the tables have the following significance.

A_0 = the percentage of ethylene in the original mixture
A' = the percentage of ethylene found in the exit gas
A'' = the percentage of ethylene calculated to be present
O_2 = the amount of oxygen present in the original mixture
O_2' = the amount of oxygen found in the exit gas
O_2'' = the amount of oxygen calculated to be present
f = the fraction of carbon dioxide in the final mixture
F = the percentage of carbon dioxide in the final mixtures ($F = 100f$)
x = the fraction of the ethylene oxidized
X = the percentage of ethylene oxidized ($X = 100x$)
B = temperature of bath surrounding catalyst tube
C = temperature of catalyst during reaction

TABLE I

SILVER CATALYST

Gas mixture: (A) Ethylene, 27.00%; (O_2) Oxygen, 18.00%

Temperature B	C	Rate, cc. per min.	Final gas analysis A'	O_2'	F	Calcd. X	A''	O_2''
310	313	30	25.90	12.89	3.79	6.63	26.13	12.99
310	311	50	25.85	14.82	2.87	5.17	26.34	14.21
310	312	60	26.25	15.05	2.51	4.55	26.42	14.68
310	313	180	26.10	17.86	1.32	2.41	26.70	16.32
200	201	30	26.50	18.20	0.66	1.22	26.85	17.13
200	201	60	26.42	18.28	.66	1.22	26.85	17.13
200	200	180	26.85	18.62	.44	0.87	26.80	17.42
	Gas mixture:		(A) Ethylene, 19.00%; (O_2) Oxygen, 26.50%					
300	302	30	17.30	19.25	4.24	10.72	17.60	20.76
300	301	60	18.20	21.06	3.56	9.01	17.90	22.12
300	301	100	18.41	23.51	2.33	6.00	18.28	23.62
300	302	140	18.73	24.30	1.94	5.00	18.40	24.10
300	304	180	18.96	22.48	1.52	3.94	18.53	24.64

TABLE II

COPPER CATALYST

Gas mixture: (A) Ethylene, 30.00%; (O_2) Oxygen, 18.00%

Temperature B	C	Rate, cc. per min.	Final gas analysis A'	O_2'	F	Calcd. X	A''	O_2''
310	310	30	29.80	1.87	11.02	16.65	27.80	3.48
310	312	60	28.80	6.16	8.80	13.50	23.24	6.40
310	324	100	29.50	8.80	6.64	10.37	28.68	9.25
310	327	180	29.45	12.55	4.26	6.84	29.15	12.37
	Gas mixture:		(A) Ethylene, 24.00%; (O_2) Oxygen, 19.20%					
290	290	30	23.50	16.38	2.09	4.26	23.46	16.47
290	290	95	24.20	18.04	0.98	2.03	23.75	17.92
290	290	180	24.61	17.08	0.76	1.57	23.80	18.21

Defendant's Exhibit 80 (continued)

TABLE II (*Concluded*)

Gas mixture; (A) Ethylene, 19.50%; (O_2) Oxygen, 27.50%

Temperature B	Temperature C	Rate, cc. per min.	Final gas analysis A'	Final gas analysis O_2'	Final gas analysis F	Calcd. X	Calcd. A''	Calcd. O_2''
300	306	30	14.45	5.58	17.76	38.70	14.09	5.75
300	317	60	15.72	6.50	14.42	32.30	15.10	9.82
300	330	140	16.88	13.68	10.62	24.65	16.26	14.48
300	320	180	17.25	16.40	8.84	20.85	16.80	16.65
200	200	30	19.00	24.65	2.13	5.36	18.85	24.89
200	200	60	19.23	25.02	1.85	4.64	18.94	25.55
200	205	180	19.43	26.10	0.96	2.45	19.20	26.32
300		30	27.80	3.87	11.02	16.65	27.80	3.48
260		30	29.55	12.25	4.53	7.19	29.10	12.08
200		30	23.56	16.39	2.09	4.26	23.46	16.47
150		30	29.20	20.18	1.18	2.00	28.75	19.78
106		30	23.75	18.73	0.54	1.14	23.86	18.90

TABLE III

PLATINUM CATALYST

Gas mixture: (A) Ethylene, 20.00%; (O_2) Oxygen, 18.00%

Temperature B	Temperature C	Rate, cc. per min.	Final gas analysis A'	Final gas analysis O_2'	Final gas analysis F	Calcd. X	Calcd. A''	Calcd. O_2''
210	227	60	17.08	7.93	7.62	17.65	17.72	7.97
203	212	60	17.78	9.00	7.02	16.38	17.90	8.76
198	212	60	18.00	10.37	6.13	14.45	18.16	9.90
170	175	60	18.60	13.14	3.94	9.45	18.82	12.80
160	165	60	18.85	14.72	2.60	6.33	19.22	14.56
130	125	60	19.50	16.78	1.31	3.23	19.61	16.27
115	115	60	19.95	17.30	0.64	1.59	19.81	17.15
90	90	60	19.85	18.07	0.22	0.55	19.95	17.71

Gas mixture: (A) Ethylene, 29.00%; (O_2) Oxygen, 21.20%

200	215	30	26.45	4.40	12.53	19.22	26.48	5.18
200	215	60	27.30	8.80	10.10	15.90	27.88	8.30
200	220	100	27.06	10.63	7.98	13.00	27.32	11.02
200	225	140	27.50	13.09	6.15	10.08	27.71	13.38
200	235	180	27.99	14.10	5.50	8.97	27.85	14.22
130	130	30	28.43	18.59	2.18	3.67	28.44	18.49
130	130	60	28.68	20.42	0.76	1.30	28.84	20.32
130	130	180	28.70	20.65	0.54	0.93	28.89	20.51

Gas mixture: (A) Ethylene, 21.50%; (O_2) Oxygen, 26.50%

300	300	30	15.50	1.18	21.00	40.40	15.50	0.55
300	308	60	16.00	2.24	20.08	38.00	15.80	1.75
300	329	120	16.40	5.18	17.06	33.95	11.64	5.45
300	335	180	17.78	7.35	15.35	31.00	17.31	7.55
200	200	30	15.53	4.23	18.35	36.10	16.26	3.80
200	217	60	16.50	5.03	18.06	35.60	16.36	4.25
200	223	180	17.75	11.41	12.80	26.40	17.85	10.68
110	110	30	21.00	25.80	0.76	1.75	21.29	25.50
95	95	30	21.78	25.90	0.66	1.64	21.31	25.68
90	90	30	21.00	25.95	0.55	1.36	21.34	25.82

Defendant's Exhibit 80 (continued)

TABLE III (*Concluded*)

Gas mixture: (A) Ethylene, 21.30%; (O_2) Oxygen, 16.85%

Temperature B	Temperature C	Rate, cc. per min.	Final gas analysis A'	Final gas analysis O_2'	Final gas analysis P	Calcd. X	Calcd. A''	Calcd. O_2''
300	304	60	17.68	1.34	12.13	26.45	17.93	0.75
300	306	60	17.96	1.54	12.00	25.15	17.84	0.87
250	255	60	18.63	6.02	8.33	18.00	18.91	5.75
200	203	60	19.95	10.85	5.76	12.77	19.65	9.19
150	150	60	20.39	12.36	3.57	8.10	20.28	12.08
100	100	60	20.56	14.29	1.75	4.02	20.80	14.52
Gas mixture: (A) Ethylene, 22.65%; (O_2) Oxygen, 17.50%								
310	315	60	19.20	2.07	11.65	23.08	19.46	2.07
280	285	60	19.00	4.83	10.60	20.10	19.92	4.25
260	262	60	20.25	7.67	7.80	16.00	20.51	7.17
220	222	60	20.85	11.13	5.18	10.85	21.83	10.64
134	135	60	22.50	15.70	1.53	3.33	22.23	15.47
120	120	60	22.50	16.64	1.08	2.36	22.35	16.07
95	95	60	22.62	16.73	0.86	1.88	22.41	16.36

TABLE IV

PALLADIUM CATALYST

Gas mixture: (A) Ethylene, 24.00%; (O_2) Oxygen, 20.50%

Temperature B	Temperature C	Rate, cc. per min.	Final gas analysis A'	Final gas analysis O_2'	Final gas analysis P	Calcd. X	Calcd. A''	Calcd. O_2''
300	304	30	20.52	2.15	14.42	26.28	20.25	1.80
300	309	60	21.60	5.17	12.12	22.54	20.85	4.81
300	312	100	21.56	7.00	10.60	20.00	21.24	6.75
300	315	140	21.95	9.08	9.11	17.40	21.63	8.70
300	330	180	22.21	10.12	8.25	15.88	21.85	9.82
200	205	30	22.58	13.75	6.49	12.73	22.31	12.09
200	205	60	23.55	14.65	4.74	9.45	22.86	13.30
200	210	100	23.60	16.40	2.86	5.80	23.26	16.80
200	210	180	24.20	19.30	0.58	1.20	23.85	19.75
250	254	30	21.80	5.80	11.02	20.70	21.13	6.20
250	255	60	21.88	9.10	9.05	17.28	21.63	8.78
250	255	100	22.06	8.96	7.98	15.40	21.92	9.15
250	259	140	22.05	10.98	7.21	14.00	22.13	11.15
250	262	180	22.40	12.06	6.71	13.10	22.25	11.80
Gas mixture: (A) Ethylene, 21.00%; (O_2) Oxygen, 25.00%								
300	304	30	16.28	0.96	19.70	39.18	15.29	0.40
300	309	60	16.38	2.73	17.60	35.70	15.90	3.00
300	310	100	16.58	5.15	16.05	33.00	16.35	4.98
300	313	140	17.08	7.20	14.42	30.00	16.80	6.90
300	319	180	16.50	8.17	13.18	27.90	17.08	8.50
200	204	30	16.08	3.29	18.15	36.70	15.74	2.30
200	205	60	15.85	4.81	16.55	33.85	16.20	4.32
200	208	100	17.15	7.15	14.42	30.00	16.80	6.90
200	214	140	17.85	14.77	12.72	26.90	17.32	14.10
200	215	180	17.84	11.94	11.42	24.60	16.28	11.75
110	110	30	21.00	24.70	0.83	2.00	20.85	24.34
110	110	30	20.53	23.30	0.98	2.30	20.72	23.77

Defendant's Exhibit 80 (continued)

In the tables under the headings A', O_2' and F are given the results of the quantitative analysis of the gases after reaction. The column headed X gives the percentage of ethylene oxidized provided the reaction proceeds according to the following reaction: $C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$. The fraction of ethylene oxidized is given by $x = 100\,f/(2A + 2Af)$, so that $100\,x = X$. From the amount of carbon dioxide formed it is also possible to calculate the amount of ethylene and oxygen which should be present with this carbon dioxide provided the oxidation of ethylene is complete. The calculated percentage of ethylene in the products of reaction is given by $A'' = A + f\,(A - 50)$, while for oxygen we have $O_2'' = O_2 + f\,(O_2 - 150)$. The values calculated for ethylene and oxygen check the experimental values very well and probably within the limits of the experimental error in the gas analysis.

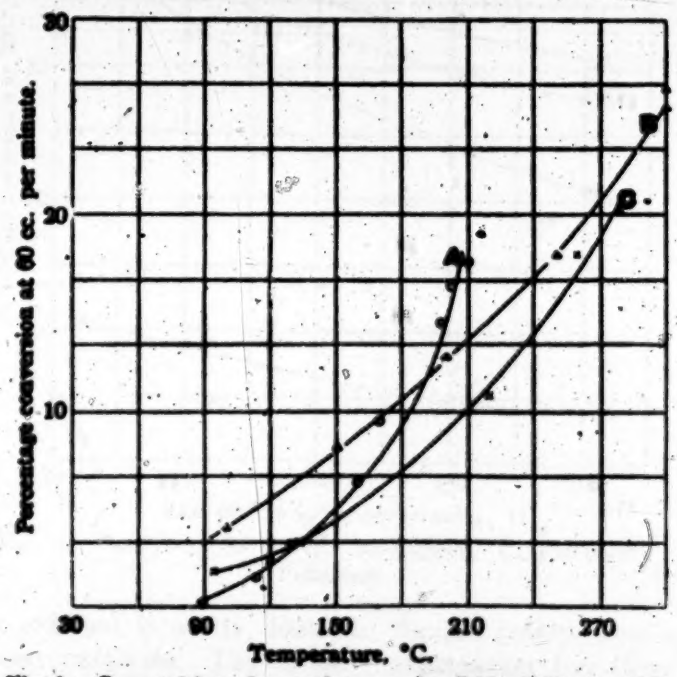


Fig. 1.—Composition of gas mixture: A = C_2H_4, 20%; O_2, 18%. B = C_2H_4, 21.3%; O_2, 16.85%. C = C_2H_4, 22.65%; O_2, 17.5%.

Discussion and Results

It is evident from these results that the catalysts used were effective in promoting the oxidation of ethylene at lower temperatures than previously reported. The copper, platinum and palladium catalysts began to be effective at about 100°. Fig. 1 shows the effect of temperature on the oxidation of ethylene for three different gas mixtures with platinized silica gel as the catalyst. The effect of increased rate of streaming on the con-

Defendant's Exhibit 80 (continued)

version is shown graphically in Fig. 2. The silver catalyst is shown to be less effective than the other catalysts. The catalysts all speeded up the successive oxidation reactions so that no intermediate products were detected. This confirms the previous work on the oxidation of ethylene.

The experimental results here given indicate that the reaction is directly proportional to the oxygen concentration and inversely proportional to the ethylene concentration. For example, when the ratio of ethylene to oxygen is changed from 1.36 to 0.81, the amount of ethylene oxidized by the platinum catalyst at 200° increases from 19.22 to 36.10%. Thus

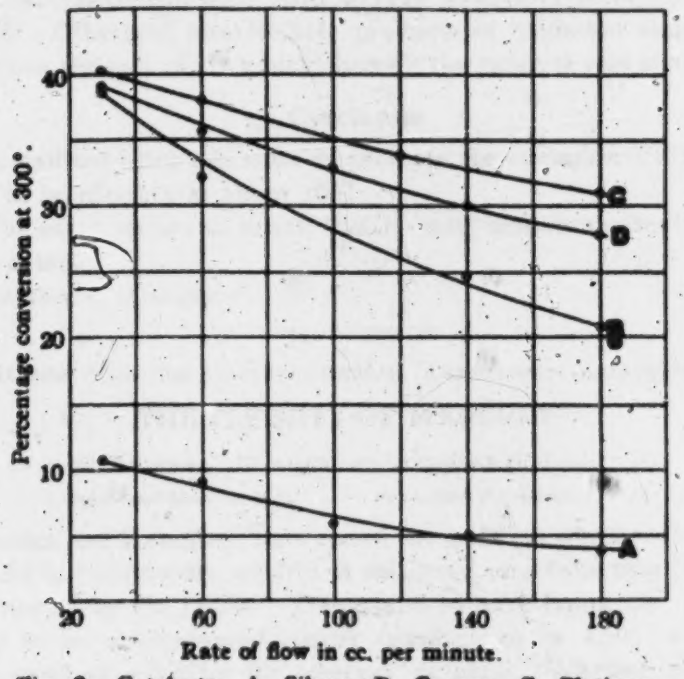


Fig. 2.—Catalysts: A, Silver; B, Copper; C, Platinum; D, Palladium.

the amount oxidized is nearly doubled. Similar results were obtained with the other catalysts. The simplest explanation for these results would seem to be that collisions of ethylene molecules with oxygen molecules which are adsorbed and activated by the effective catalyst centers resulted in reaction, whereas collisions of oxygen molecules with adsorbed ethylene molecules were ineffective. The adsorption studies of the authors[6] indicate specific adsorption of both ethylene and oxygen by these catalysts. Therefore, when the ethylene molecules are adsorbed by the active catalyst centers, then these centers are no longer effective. The double bond of ethylene is no doubt directed toward the catalyst. When,

[6] Reyerson and Swearingen, *J. Phys. Chem.*, 31, 88 (1927).

Defendant's Exhibit 80 (continued)

however, an oxygen molecule reaches an active center and is adsorbed, it is activated so that it is able to react with the ethylene which reaches it. Mere adsorption is not sufficient, otherwise the silica gel itself would be an active catalyst. Because of their higher energy content the primary products of oxidation are likely to be very reactive whether they are dihydroxyethylene or formaldehyde. Furthermore, as indicated in the tables, the temperature of the catalysts is often higher than that of the bath in which they are immersed. This indicates that the temperature at which the reaction takes place may be very much higher than that indicated, so that successive collisions with oxygen molecules result in complete oxidation. Otherwise intermediate products of oxidation should be detected when the rate of streaming through the catalyst was increased.

Conclusion

1. Metallized silica gels actively promote the oxidation of ethylene, beginning to be effective at about 100°.

2. The catalysts are so active that no intermediate products of oxidation are detected.

MINNEAPOLIS, MINNESOTA

[CONTRIBUTION FROM THE GAYLEY CHEMICAL LABORATORY, LAFAYETTE COLLEGE]

THE FLUIDITY OF MERCURY[1,2]

BY EUGENE C. BINGHAM AND THEODORE R. THOMPSON

RECEIVED JUNE 25, 1928 PUBLISHED NOVEMBER 6, 1928

Tammann and Hinnüber[3] have raised the question whether the viscosity of a liquid is trustworthy when it is measured in a tube that is not thoroughly wetted by the liquid. They claim to have found the viscosity of mercury in an amalgamated copper capillary to be 4.931 ± .78 *cp* at 13.5° instead of 1.609 *cp* for mercury in glass. Whether one accepts their explanation of the phenomenon based on "slippage," or not, the discrepancy of over 200%, is quite beyond experimental error and demands investigation.

1. The hypothesis of slippage is, of course, not new. It has often been offered to account for results which at the time seemed inexplicable, but on further investigation it has always been found that some factor has been overlooked which has made this explanation unnecessary. On the other hand, the fair agreement among the results of different investigators using widely different forms of viscometers and shearing stresses constitutes what may be fairly regarded as proof that slippage is certainly not

[1] In memory of Ira Remsen.

[2] Part of Master's Degree "Thesis" of Theodore R. Thompson.

[3] Tammann and Hinnüber, *Z. anorg. Chem.*, 167, 230 (1927).

Defendant's Exhibit 85.

XLVIII.—*On Oxide of Ethylene, considered as a link between Organic and Mineral Chemistry.*

[A Discourse delivered to the Fellows of the Chemical Society of London, June 5th, 1862.]

By M. Ad. Wurtz.

In the year 1795, four Dutch Chemists, Deiman, Troostwyk, Bondt, and Lauwerenburgh, first made the remarkable experiment of bringing together equal volumes of chlorine and olefiant gases, whereby they obtained a liquid compound, still known by the name of "Dutch liquid." This compound is an organic chloride, the dichloride of the diatomic radicle, olefiant gas or ethylene; and its constitution, or rather its mode of formation and most of its chemical properties, show that it may be represented by the formula

$$(C_2H_4)''Cl_2$$

Oxyde of ethylene is the corresponding oxide—

$$(C_2H_4)''O$$

This oxide cannot be formed directly by the action of oxygen on ethylene,* but it is obtained as a derivative of glycol, of which it is the anhydride or ether.

I must here draw attention to the re-actions by which glycol is produced, for they exhibit a remarkable peculiarity, on which I must especially insist. I obtained this body by the action of potash or baryta on diacetic glycol, a compound produced by the action of bromide or iodide of ethylene on acetate of silver, as shown by the following equation:—

$$(C_2H_4)''I_2 + \left\{\begin{matrix} C_2H_3O \\ Ag \end{matrix}\right\} O \Bigg\} + \Bigg\{ \begin{matrix} Ag \\ C_2H_3O \end{matrix}\Big\} O = 2AgI + \left\{\begin{matrix} C_2H_3O \\ C_2H_4 \\ C_2H_3O \end{matrix}\right\} O_2$$

Here we see clearly that 2 atoms of silver are removed, and their place supplied by ethylene, which, thus, as it were, rivets

* I have in vain endeavoured to bring about the direct combination of oxygen and ethylene, by heating a mixture of the two gases in the required proportions in a sealed flask containing acetic acid. I hoped to obtain by this method the acetate of ethylene or acetic glycol.

Defendant's Exhibit 86

N° 21,941 A.D. 1905

(Under International Convention.)

Date claimed for Patent under Patents Act, 1901, being date of first Foreign Application (in Germany), 27th Oct., 1904

Date of Application (in the United Kingdom), 27th Oct., 1905

Under Section 1 (2) of the Patents Act, 1901, this Specification became open to public inspection at the expiration of twelve months from the date of the application in Germany

Accepted, 27th Oct., 1906

COMPLETE SPECIFICATION.

Process for the Transformation of Organic Substances by Partial Combustion.

I, Doctor JOHANN WALTER, resident of 30 Chemin des Cottages, Geneva, Switzerland, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

This invention relates to a process for the transformation of organic substances into others of greater commercial value by partial combustion substantially as hereinafter described.

Already in the year 1895, I published in the "Journal für Praktische Chemie" (New Series, vol. 51, page 107) an article entitled "Some experiments in oxidising by means of partial combustion": it was found however that the process there described could not be carried out profitably in practice. Since then I have continued my experiments, and the improved process which forms the subject-matter of the present application for patent is the result. I have now discovered the proper conditions under which the partial combustion must take place, which conditions are:

a) Thorough mixing of the gases, pulverized or vaporised substances to be treated with air, or in certain cases oxygen, as well as in some instances with steam, before they are conducted into the heating chamber. This mixing may be accomplished by means of a mechanically operated fan or any equivalent mixing apparatus.

b) Maintaining certain degrees of temperature in the heating chamber, which temperatures do not depend only upon the substance to be treated, but also on the speed of the current of gas or eventually current of steam, and on the cross-section of the heating chamber.

c) Mixing steam with the mixture of the substance to be partially burnt and air or, in certain cases, oxygen. The steam acts as a diluting agent,

 [*Price* 8*d.*]

Defendant's Exhibit 86 (continued)

2 N° 21,941.—A.D. 1905.

Process for the Transformation of Organic Substances by Partial Combustion.

prevents explosions, absorbs any excess of heat of combustion and facilitates the condensation of the transformed products.

d) Employment of the proper contact substance in those cases where such is necessary.

e) Employment of a combustion chamber of a cross section suited for the particular substance being treated, in certain cases the division or distribution of the well-mixed current of vapors and gas in a number of small heated tubes.

I will give a few instances of the applications of my invention:

Instance 1: As in the process of producing formic aldehyde according to the system of Loew-Tollens, as described in the "Berichte der Deutschen Chemischen Gesellschaft", 19th year, page 2133, so according to the process forming the object of the German Patent 55176 it is necessary to employ an excess of methyl alcohol in order to obtain a good yield of aldehyde, in relation to the alcohol consumed. The practical man knows this very well. The German Patent 106495 likewise draws attention to this point, and states moreover that this excess could be avoided by sprinkling methyl alcohol over large surfaces over which the air sweeps as a counter-current above the said alcohol; as also by adding nitrogen with the air. The nitrogen, however, not only uselessly increases the volume of incondensable gas and thus renders the condensation of the aldehyde difficult, but it has also been seen already, that the excess of methyl alcohol cannot thus be avoided, if it be incumbent to obtain as large a yield as possible. If on the contrary, instead of a gaseous means of dilution such as nitrogen or carbonic acid, steam be added, the object will be completely attained. It is true that the reaction $H.CH_2OH + O = H.COH + H_2O$ already gives 1 molecule of water but that is not enough to produce the favourable influence mentioned. Calculated in relation to the liquid of condensation, this molecule is approximately 37·3 *per cent* water. In order to obtain after cooling a solution of formic aldehyde of the usual degree, *viz.*, 10%, 22·7% of water may thus be added in the form of steam to the methyl alcohol vapours charged with air, before they are introduced into the heating chamber.

For the purpose of practically effecting the reaction, a copper vessel capable of holding about 100 litres is placed in a wooden cask, employed as a water bath. At the bottom of this vessel and inside the same is a copper coil perforated with small holes. The coil is continued outside and surrounds the vessel at a distance of about 50 mm and is likewise in the water bath. Through this coil a current of air is passed which can always be kept at the same pressure. The air is heated in the coil in the water-bath, passes out at the bottom of the copper vessel through the small openings in the coil, flows through the filling consisting of methyl alcohol and reaching to about ⅔ of the height, and becomes charged with vapour. The temperature of the water-bath is kept at 52° C by the introduction of steam. A thermometer situated in a pipe through which the mixture of methyl alcohol vapour and of air flows from the closed copper vessel, indicates 44° C. Into this pipe, behind the thermometer, a stream of controllable steam, issuing from a spraying nozzle, is introduced. This steam mixes with the stream of air carrying the methyl alcohol vapours. In looking further into the apparatus we find at a distance of about 10 mm apart two iron-wire pieces of net-work with fine meshes in the outflow pipe which separates behind the net-work into three short horizontal pipes each of which runs into a vertical copper pipe of about 80 mm diameter, containing a powder composed of asbestos and copper placed in thin layers on stout perforated copper plates.

At the beginning of each operation the asbestos and copper powder in each tube is heated to red heat by means of a blow-pipe applied to the outside of the tube at one of the places where the asbestos and copper touch the inside of the tube. The red heat begins to extend equally over the three layers and is self-maintained by the heat of combustion and is observed from

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Defendant's Exhibit 86 (continued)

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Process for the Transformation of Organic Substances by Partial Combustion.

time to time through mica doors placed above the layers. Below this the three pipes are joined again and form a single pipe, which enters a refrigerator with a pipe from which the condensed liquid, which causes an aerometer to float at some place in its course suitable for observation, flows into a collector, in which the aqueous solution of formic aldehyde is collected. The non-condensed vapours and gases before passing into the atmosphere flow through a small cylinder sprinkled with water and filled with pumice stones.

Instead of injecting air through the heated methyl alcohol the latter may be also distributed in the mixture of air and steam by means of a spraying nozzle or the methyl alcohol vapours separately prepared may be added to it. Further the pipe described in the communication as "a simple heating and refrigerating device for use in industry" which I have described in Part 2 of the "Chemische Industrie" for the year 1897 is heated internally with steam under pressure. A mixture of 4·3 parts of methyl alcohol and 1 part of water is injected to $^2/_3$ of the height of this pipe and air is admitted near A below in the external casing pipe whilst r is closed. In this case it is only necessary to regulate the air in order to obtain the determined proportion of mixture of air and methyl alcohol on the one hand and of steam on the other.

One volume of a natural gas consisting for the most part of methane (CH^4), thoroughly mixed with 5 volumes of air and 2 volumes of steam, is conducted into a tubular vessel closed at one end, and heated at the closed end to a powerful glowing heat, so that the relatively narrow supply pipe opens in the place where the heat is the greatest. Here the methane is consumed, the resulting product being formaldehyde and water. The vapours passing out of the heating chamber heat the fresh vapours flowing through the narrow middle tube, the first vapours hereupon entering a cooling device in which an aqueous solution of formaldehyde is deposited.

Instance III: A mineral oil distillate, boiling above 300° C., is sprayed into a current of air mixed with steam: this mixture is conducted over a contact substance consisting of asbestos coated with finely divided copper oxide, which is at a red heat, and then cooled in a condensing apparatus. By proper regulation of the proportions of the air and steam, the contact substance maintains itself at a red heat without further heat being applied outside. The product of condensation flowing out of the cooler has a strong acid reaction, the larger aqueous layer contains acetic acid and its homologues. From the oily layer floating at the top, an organic acid which solidifies at 0° C. can be separated by means of a soda solution and thereafter be precipitated by means of mineral acids and thereupon, by means of bisulphite of soda solution, an aldehyde which likewise solidifies and has a scent similar to peppermint. The principal quantity remaining is an oily fluid which begins to boil at 140° C. and of which up to 300° C. one half is distilled. The present process accordingly, like the so-called cracking process enables products of petroleum distillation boiling at a high temperature to be converted into products which boil at a low temperature.

Instance IV: In Beilstein's Handbook of Organic Chemistry 3rd Edition, vol. 1, page 112, it is stated: "An excess of ethylene with oxygen passed through a tube heated to 400° C. yields much trioxymethylene." It has not been possible heretofore to turn this reaction to practical account, owing to the excess of ethylene (C^2H^4), which has been lost. If only the theoretical combining quantities of ethylene and oxygen or air were taken, an explosion resulted. But if ethylene be mixed with the proper quantity of oxygen or air, and steam be then added thereto, and all thoroughly mixed before being passed into the heating chamber, the whole of the ethylene is recovered as formaldehyde or an aqueous solution of the same. In this case I find it preferable to form the heating chamber of a number of small narrow pipes.

Acetylene (C^2H^2) combines with hydrogen to form ethylene and consequently thereupon may be transformed by my process into formaldehyde. Ethylene

Defendant's Exhibit 86 (continued)

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Process for the Transformation of Organic Substances by Partial Combustion.

may also be obtained almost quantitatively from ethyl alcohol, either by G. S. Newth's method, *i.e.* dropping the ethyl alcohol on phosphoric acid heated to 200–220° C, or by W. Ipatiew's method, *i.e.* conducting the vapours of ethyl alcohol over heated aluminium oxide.

Instance V: In the manufacture of dimethylaniline from aniline, methyl alcohol and sulphuric acid, a gas consisting of methylether ($CH_3 \cdot O \cdot CH_3$) escapes on the cocks being opened after the cooling of the digesters. This gas has hitherto been allowed to escape into the atmosphere or it has been burnt up and thus transformed into carbonic acid and water. My process enables this gas to be turned to account by transforming it into formaldehyde. Manganous hydroxide is precipitated upon asbestos, then washed and dried and placed in a tube where it is heated to a low, barely noticeable red heat. As in the case of methane in Instance II, the methylether is thoroughly mixed with the necessary quantity of air and steam; and the mixture is then conducted over the manganous asbestos. On condensation of the vapors, an aqueous solution of formaldehyde is obtained.

This specification would run to too great a length were I to add more instances. I will only add that the reactions specified in Instances I, III, and V, by proper regulation of the temperature of the heating chamber, take place in the same manner but quantitatively with less favorable results, when no contact substance is employed; and on the other hand contact substances may also be employed in the reactions specified in Instances II and IV. The following may be employed as such contact substances: The metals platinum, iridium, palladium, silver, uranium, vanadium, iron, cobalt, nickel, cerium, thorium, copper, manganese, titanium, didymium, tungsten, also lead oxide by itself or mixed with lime, and chromoxide by itself or mixed with aluminium oxide or with lime—to which last mixture some potash may, in certain circumstances, be added. Molybdenic acid and thallium oxide may also be employed, but they volatilise readily, and they can only be recovered with difficulty. Arsenic and mercury may also be used as contact substances: they also volatilise, but their recovery is simple. In employing mercury for instance, some of it may be vaporised. The current of gas passing from the heating chamber carries quicksilver vapours with it: after partial cooling the current is conducted over rolls of copper or gold-wire net, on which the quicksilver forms an amalgam and is thus retained in the apparatus. By now reversing the direction of the current of gas and heating the amalgam, the quicksilver is given up again to the current, and after passing through the heating chamber it is absorbed by other copper rolls or equivalent, thus always remaining in the apparatus ready to play its part in the process.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1) A process for the transformation of organic substances to others of greater commercial value, by a partial combustion consisting in the condition that the partial combustion must take place under proper conditions which are: a° Thorough mixing by mechanical means, of the gas or substances to be transformed, with air, oxygen, or in certain cases with steam, before it enters the heating chamber; b° mixing with the above mixture, steam acting as diluting agent, c° maintaining particular temperature in the heating chamber.

2) A process for the transformation of organic substances into others of greater commercial value, by a partial combustion consisting in the condition that, in certain cases for the partial combustion as in Claim 1, the combustion must be carried out with contact substances and in other cases without any contact substances;

3) A process in accordance with Claim 1 for the transformation of organic substances into others of greater commercial value, by a partial combustion,

Defendant's Exhibit 86 (continued)

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characterized by the condition, that in cases where a heating chamber of small section is necessary the mixed current of gas and vapor is distributed in a plurality of heating tubes of small inner diameter.

Dated this 27th day of October 1905.

WHEATLEY & MACKENZIE,
40, Chancery Lane, London, W.C.,
Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1906.

DEFENDANT'S EXHIBIT 88

Liebig's Annalen der Chemie
1921, Vol. 422, pp. 36-46

III. The preparation of formaldehyde from ethylene

R. Willstätter & Max Bommer

* * *

Only at temperatures above 500°C. is ethylene rapidly oxidized by molecular oxygen. Under the experimental conditions of Bone and Wheeler its combustion proceeds at a very low velocity. With an ethylene oxygen mixture flowing through a glass tube with a time of heating of 1 second we observe at 410-450°C. only traces of a penetrating odor; with a mixture consisting of 60% ethylene, 5% of oxygen and 35% of nitrogen under the conditions of the experiments described further on a very faint odor of formaldehyde and a slight reddish discoloration of fuchsine-sulfurous acid appears at about 500°C.

It is obvious to lower the temperature of the slow combustion of ethylene by catalysts. However, whilst for the formation of formaldehyde from methyl alcohol, a dehydrogenation process, copper and silver are found to be serviceable, we find that for the oxidation of ethylene to formaldehyde accelerators of all kinds, viz. metals, such as osmium, platinum, silver and copper, as well as metal oxides, as for example those of cobalt, chromium, manganese and uranium, are utterly useless. The contact substances speed up the oxidation and lower the combustion temperature of the hydrocarbon, but they cause no formaldehyde to be formed. The unfavorable effect may either be due to the circumstance that they cause the action of oxygen on ethylene to proceed in another manner and lead to other oxidation products, or to the circumstance that they accelerate the dissociation of the formaldehyde even more than its formation.

It is already known that formaldehyde dissociates with great velocity into carbon monoxide and hydrogen even without any such contact action and already at a lower temperature than the one suitable for the preparation from ethylene. Thus W. A. Bone and H. L. Smith

described its decomposition from 400°C. onwards, and P. Sabatier has dealt in detail with the dissociation in the presence of metals and oxides.

As already shown by the investigation of F. C. Phillips on the oxidation of hydrogen and hydrocarbons, the combustion temperature is lowest in the presence of osmium. With ethylene we observed commencement of oxidation at 180°C. with direct formation of carbon dioxide; at 200°C. the oxygen was used up. With copper and silver likewise no formaldehyde was formed, and even with an excess of ethylene no carbon monoxide appears. The action of copper was already considerable at 250°C., at 400°C. and with a mixture of 80% of ethylene and 20% of oxygen half of the oxygen was consumed for forming carbon dioxide, and half of it by the copper.

On introducing a copper wire into the reaction space under the conditions most favorable to the formation of formaldehyde the formaldehyde disappears entirely; iron in a compact form, however, is harmless. • • •

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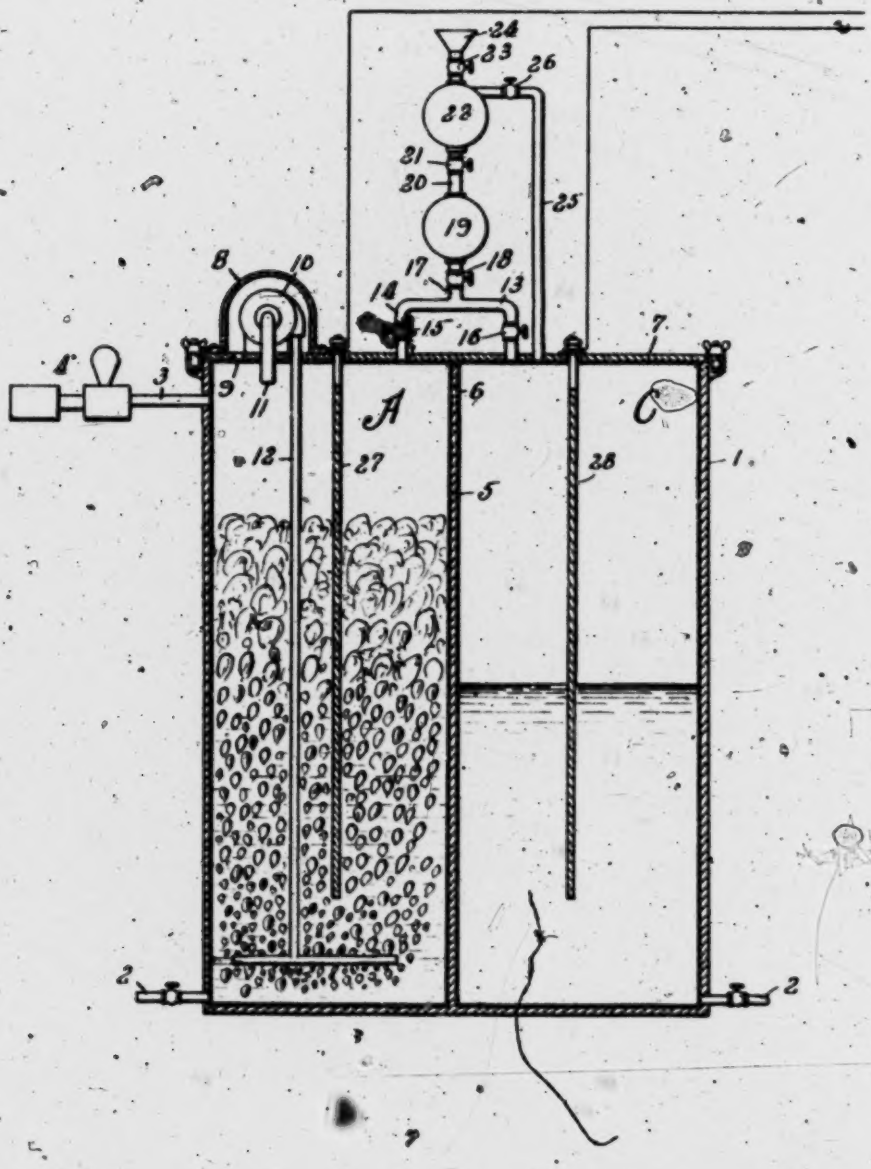
K. P. McELROY.

PROCESS OF AND APPARATUS FOR OXIDIZING HYDROCARBONS.

APPLICATION FILED AUG. 2, 1912. RENEWED MAR. 18, 1916.

1,253,617. Patented Jan. 15, 1918



Witnesses
H. C. Robinette
Dorsey Griffith

Inventor
K. P. McElroy

UNITED STATES PATENT OFFICE.

KARL P. McELROY, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR TO CHEMICAL DEVELOPMENT COMPANY, A CORPORATION OF MAINE.

PROCESS OF AND APPARATUS FOR OXIDIZING HYDROCARBONS.

1,253,617. Specification of Letters Patent. Patented Jan. 15, 1918.

Application filed August 2, 1912, Serial No. 712,975. Renewed March 18, 1916. Serial No. 85,200.

To all whom it may concern:

Be it known that I, KARL P. MCELROY, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Processes of and Apparatus for Oxidizing Hydrocarbons, of which the following is a specification.

This invention relates to processes of oxidizing hydrocarbons; and it comprises a method of producing useful products from ethylene and other gaseous and highly reactive unsaturated hydrocarbons wherein such a hydrocarbon is submitted to a direct limited oxidation in solution, the progress of the reaction being so controlled as to limit the extent of the oxidization to the production of simple oxygen-containing derivatives of such hydrocarbon and to preserve unattacked hydrocarbon in the sphere of reaction during the course of such reaction; all as more fully hereinafter described and as claimed.

There are various oxygen-containing or oxidized derivatives of ethylene, such as glycol, the chlorhydrin, glycol esters, glycol ethers, ethylene oxid, etc., having properties which would render them useful in various arts if such derivatives could be produced by a method sufficiently simple, cheap and ready to make them commercially available. At present however these bodies are not available for technical purposes being merely laboratory curiosities, made when wanted for scientific purposes by indirect, cumbrous and wasteful methods. Ordinarily, ethylene, made from alcohol, is converted into a dihalid and this is then saponified or esterified to replace the halogen by other groups. Saponification and esterification are both operations attended with some difficulty and giving small yields since the dihalids are stable, little reactive substances. Glycol, for example, is usually made for scientific purposes by converting ethylene, produced from alcohol, into the dibromid, converting the dibromid into an acetic ester and finally saponifying the latter by alkali.

It is an object of the present invention to obtain these potentially valuable oxidized bodies from ethylene and other olefinic gases by a direct limited oxidation under controlled conditions. Ethylene which is typical of the other olefinic gases is a readily oxidizable substance but being endothermically constituted, oxidation is attended with the liberation of much energy and is apt to be too far going, while the direct products of its limited oxidation, ethylene oxid, glycol and chlorhydrin are themselves also readily oxidizable. Ethylene oxid, which is the first product of oxidation, is particularly sensitive; glycol is more resistive.

I have found however that under suitable conditions the oxidation of ethylene can be limited and regulated to the desired degree and that such a limited oxidation of the ethlyene itself is, so to speak, preferential over the further oxidation of these proximate oxidation products; that is, so long as unattacked ethylene remains in the sphere of reaction the oxidation merely goes to the first stage and the ethylene exercises a protective action shielding the proximate products from further attack. In the present invention therefore conditions are so controlled as to restrain the violence of reaction, the heat of reaction being absorbed or removed as fast as evolved so as to maintain a predetermined temperature range; and an excess of ethylene is maintained in the sphere of reaction throughout the course of such reaction. While other methods of temperature control may be, and usefully are, employed dilution of the reacting bodies is desirable as this also aids in controlling the progress of the reaction. As stated, ethylene is endothermic and tends to enter into reaction with accelerating velocity; and dilution is useful in damping down the violence of the action.

Dilution is useful in the limited oxidation of ethylene in the gaseous state by chlorin and steam, steam being best present in ample amount, and by oxygen in the presence or absence of catalytics, such as platinum black, labile oxids, nitrous vapors, etc.; and in the treatment of ethylene dissolved in various liquids; advantageously an aqueous liquid. The solubility of ethylene in most aqueous liquids is relatively small so that even a saturated solution thereof is still actually, as regards the ethylene, very dilute; and the heat of oxidation becomes a limited quantity readily taken up and controlled by the liquid solvent. In fact the solubility of ethylene as ethylene in most aqueous liquids is so small as compared with that of many of the ordinary oxidants that in oxidizing in

aqueous solution special means must ordinarily be adopted to maintain the ethylene solution replenished with the gas and prevent the chance of an excess of such oxidant existing at any time during the reaction.

Several expedients to this end may be employed. One is an increase in pressure which causes a concomitant increase in the solubility of ethylene. With 15 pounds gage pressure, the amount which can be held in solution and drawn upon for reaction is about doubled. Another is quicker replenishment of the supply of dissolved ethylene by filming the liquid or otherwise increasing the area of contact between liquid and gas. Vigorous agitation of the liquid to prevent localized changes in the relative concentration of ethylene and oxidant is desirable. The increase in area of contact and the agitation may be simultaneously attained and a number of other desirable results secured by causing a cyclic circulation of the gas to, through and back to the reaction liquid; that is with a reaction chamber having a gas feed and means for withdrawal of waste gas there may be provided additional means capable of continuously taking gas from above the body of liquid and again bubbling it therethrough. Advantageously there may be employed a fan or blower. The fan means may be, and advantageously is, speeded up so as to maintain an emulsion of liquid and gas.

Another expedient often useful is to maintain porous, adsorptive materials, such as charcoal, coke, boneblack, platinum black, etc., suspended in the liquid in which the oxidant is contained or in which it is being developed to absorb gas and re-deliver it to the liquid. Such bodies may, and usually do, superadd a useful catalytic effect in aiding oxidation. For example, ethylene and air may be supplied to a hot liquid holding platinum black or colloidal palladium or the like in suspension.

Still another expedient is to maintain in contact with an aqueous reaction liquid or bath an oily liquid having a greater solvent power for ethylene to act, so to speak, as a store of ethylene. Oil of turpentine, for example, dissolves about 2½ times its volume of ethylene so that a drop of the oil saturated with a gas holds 2½ times as much ethylene as a bubble of the gas itself of the same size as such a drop. The use of an oily carrier of this kind is particularly advantageous with gases poor in ethylene, since it takes up ethylene and other unsaturated hydrocarbon gases with greater readiness than it does many other gases. In order to increase the surface of contact between the oily carrier and the aqueous oxidizing bath they should be kept emulsified together; and to promote ease of emulsification it is often useful to increase the specific gravity of the oil by mixing therewith heavy chlorinated oily bodies, such as chloroform, carbon tetrachlorid, Dutch liquid, etc., to an extent sufficient to make the specific gravities of the carrier and the bath at least approximately the same. And, vice versa, in using the heavy chlorinated products, a little petroleum hydrocarbon may be admixed to lighten them. However, with efficient stirring means the specific gravity of the carrier employed may not be important.

It is commonly useful to employ several of these expedients simultaneously as in feeding ethylene to an oxidizing chamber maintained under pressure as high as convenient, provided with means for cyclic gas circulation and containing in addition to the aqueous oxidizing bath an immiscible oily gas absorbent. However such expedients may be separately used.

The ethylene used in the present invention may be produced from any of the usual sources, as by dehydrating alcohol, by hydrogenating acetylene or by destructive distillation or cracking of coal, oil or other carbonaceous bodies. Using ordinary coal gas as a source of ethylene, it is useful to extract ethylene and other olefinic gases by means of wash oil; though the other oily carriers described may also be used. From the wash oil, the olefinic gases may be separated in a concentrated state by heating or vacuum. By proper precaution petroleum oil may be cracked down to form gas mixtures rich in ethylene, propylene and the butylenes; and useful in the present invention.

Acetylene may be hydrogenated to ethylene by catalytics or electrolytically.

Many oxidants may be used in the present invention, such as oxidizing salts, like permanganates, chromates, vanadates, arsenates, etc., in acid, alkaline or neutral baths. Peroxidized bodies, such as hydrogen peroxid, barium peroxid, calcium peroxid, sodium peroxid, perborates, persulfates, etc., may also be used. Manganese binoxid and an acid may be employed. Bleaching powder containing a trace of cobalt or other catalytic causing an evolution of nascent oxygen may be used. When ethylene chlorhydrin is desired, the bleaching powder may be acidulated with a weak acid. Or chlorin may be led into or formed in an aqueous solution of ethylene which may also contain neutralizing bodies, such as magnesia, chalk, soda, etc., to neutralize the HCl formed.

With many of these oxidants, the addition of the same or the development of its oxidizing influence should be proportionate to the rate of solution of ethylene; there should always be unattacked ethylene in the sphere of reaction.

It is advantageous to develop the oxidiz-

ing influence electrolytically, as this gives a better control of conditions and of the rate of development of such oxidizing influence. The rate of development can be readily adjusted to the rate of solution of the ethylene. Either diaphragmed or diaphragmless cells may be used. With a diaphragmed cell acetylene may be hydrogenated to ethylene in the cathode compartment and the ethylene oxidized in the anode compartment.

Any suitable electrolyte may be employed. With a saline solution, the alkaline cathode fluid may ultimately be used to neutralize the acid anode fluid to make a neutral solution from which the oxidation products may be regained. Any suitable anode metal and cathode metal may be used, and any suitable dissolved carrier such as titanium, cerium, manganese, iron, chromium, etc., salts may be used. Sulfate of soda is suitable for many purposes as a dissolved electrolyte. With salt (sodium chlorid) and other halogen compounds, the oxidation generally gives ethylene chlorhydrin which may be saponified to glycol with the soda accumulating in the cathode compartment. Ethylene chlorhydrin may be produced in any of the cells ordinarily employed for making hypochlorites, by using ethylene, or gases containing the same, as a depolarizer.

In the manufacture of caustic soda, it is an economical procedure to pass acetylene into the cathode compartment to act as a depolarizer and also produce ethylene, while the ethylene may be similarly used as a depolarizer in the anode compartment, producing either chlorhydrin or Dutch liquid as the case may be. In this way the consumption of energy for the production of caustic soda may be much lessened while useful products are obtained to aid in paying the expense of the operation.

In the accompanying illustration I have shown, more or less diagrammatically, a generalized type of apparatus which may be used in many of the reactions described herein. In this showing

Reference character 1 indicates a vessel which may be of any suitable material, such as sheet steel, appropriately coated with a resistant inner lining. This is advantageously built so as to withstand internal pressure. It is provided with valved draw-off outlets 2 for removing liquid. It is also provided with inlet 3, supplied by pressure pump 4, through which an olefinic gas, or mixtures of such gas with any other gas desired, may be supplied under any convenient pressure. As shown, the vessel is particularly adapted for electrolytic purposes and is provided with diaphragm 5 of any usual material dividing it into an anode chamber A and cathode chamber C. This diaphragm is advantageously perforated at 6 to allow equalization of gas pressure on the two sides. The vessel is provided with cover 7 which may be clamped on in any suitable manner. This cover carries hood 8 having communication with the chamber of the vessel through orifice 9. This equalizes the chamber pressure with that of the hood 8. Within this hood is mounted any simple type of blower or pump, shown here as rotary fan 10. This blower has communication with the gas space within the chamber at 11 and is provided with conduit 12 extending nearly to the bottom of the vessel. The lid may also be provided with two conduits 13 and 14 placed on each side of the diaphragm and valved respectively at 15 and 16. These two conduits unite as conduit 17, valved at 18, which expands into chamber 19. Above this chamber is a length of tubing 20, valved at 21, and connecting with another chamber 22, above which is valve 23 and hopper or funnel 24. Equalizing pipe 25, valved at 26, allows equalization of pressure. This last described device enables equalization of gas pressure with that of the chamber by opening appropriate valves; and it also allows liquid to be fed to either side of the diaphragm and without disturbance of the chamber pressure. For example, a liquid may be fed into 24, and, valves 26 and 21 being closed, may be fed into 22 by opening valve 23. By now closing valve 23 and opening 26 and 21, (valve 18 being normally open) the liquid may be caused to pass down into 19 and thence by 16 or 15, the liquid may be discharged on either side of the diaphragm.

Anode 27 and cathode 28 may be of any suitable metal or structure adapted to a particular electrolysis.

In one embodiment of the present invention, using electrolytic oxidation, the vessel may be charged on both sides of the diaphragm with a solution of sulfate of soda of such strength as to give good conduction. Ethylene, or gas containing ethylene, may now be introduced into the apparatus by means of pump 4 at any pressure desired, say, 4 or 5 atmospheres. Upon now starting blower 10 into operation, the liquid may be kept thoroughly saturated with dissolved ethylene. It is advantageous to run this pump or blower at such a rate that the liquid is maintained as more or less of an emulsion of gas and liquid; as a foamy mass. Upon now passing a current through the device in such a manner that 27 becomes the anode, the ethylene is oxidized to glycol which goes into solution. Nascent oxygen, ozone, hydrogen peroxid, etc., produce at the anode an oxidation of ethylene in the presence of water to form glycol. The rate of development of the oxygen should be limited according to the rate of solution of ethylene so that an excess of ethylene shall remain in the solution at all times. Should the solu-

tion temporarily become exhausted of ethylene, there would be danger of the oxidation of glycol to form glycolic acid, etc. For this reason the current should be regulated in correspondance with the supply of dissolved ethylene. The apparatus may be run discontinuously, a charge of ethylene, or gas containing the same, as for example, a pyrolytic oil gas containing say 40 to 50 per cent. of ethylene and other olefins, introduced and the pump 10 kept in operation until the ethylene of the charge has become absorbed and oxidized. At this time the current may be interrupted and waste gas vented through 14. Another charge of ethylene, or gas containing the same, may now be introduced and so on until the concentration of glycol in the solution becomes as high as may be desired. In the electrolytic operation using sodium sulfate as the conductive electrolyte, alkali of course is developed in the cathode compartment in amount corresponding to the amount of acid in the anode compartment. At the end of the operation, by uniting the anode fluid and the cathode fluid, a neutral saline solution is regained and from this glycol may be isolated in ways similar to the ways of recovering glycerin from salt lyes its properties, as well as its uses, being very similar to those of glycerin. Like glycerin it is a dense, high boiling liquid which however can be blown over readily with steam. The anode may be of platinum, carbon or lead. The anode fluid may contain a carrier oxidant, such as a chrominum salt, a cerium salt, a manganese salt, etc. Other oxygen salts, such as phosphates, borates, etc., may be used in lieu of the sulfate, but the sulfates are advantageous. Sulfate of soda is a good sulfate.

In the anode chamber may be maintained a little suspended platinum black, charcoal, boneblack, etc., if desired. It may also contain an oil having solvent properties for ethylene, such as turpentine, mineral oil, etc. With proper manipulation and the maintenance of dissolved ethylene in the solution at all times, oxidation will be restricted to the ethylene.

By substituting a solution of common salt in the cell for the solution of sulfate of soda just described but otherwise operating in the same manner, the reaction with oil gas will produce ethylene chlorhydrin and other chlorhydrins. In this action since chlorin is withdrawn from the sphere of reaction in the form of chlorhydrin which is a neutral body, the alkalinity of the cathode fluid increases more rapidly than the acidity of the anode liquid. The operation may be continued until the per cent. of salt converted into alkali and chlorhydrin is as high as may be desired, the liquid being replenished with salt from time to time if desired. Operating in this manner the process becomes the manufacture of caustic soda with the use of ethylene as a depolarizer to reduce the current consumption and with the production of a valuable byproduct, the chlorhydrin, in lieu of chlorin. Ethylene chlorhydrin is valuable as a solvent in addition to its value as a material for conversion into glycol.

In case it is desired to form glycol from the chlorhydrin, the anode fluid and the cathode fluid may be united and heated with such chlorhydrin under pressure. Without pressure the action of caustic alkali on the chlorhydrin is to convert it into the corresponding oxid. The alkalinity of the cathode fluid is sufficient to neutralize the acidity of the anode fluid and also to hydrolyze the chlorhydrin which has been formed.

In using salt as the electrolyte, the diaphragm may be dispensed with and the cell worked under conditions analogous to those employed in making hypochlorites. Operating in this way, the cathode should be of small effective area to give a high current density and permit the escape of hydrogen. For this latter purpose, it may be provided with a conduit for taking away hydrogen. The ethylene being present to unite with the chlorin and with hydroxyl, the cell does not produce hypochlorites as long as it remains in excess.

In working with salt as an electrolyte, it is desirable to keep the temperatures low and to maintain the stated excess of ethylene present. In the absence of an excess of dissolved ethylene, if the electrolysis be pushed, chlorin formed as such may combine with gaseous ethylene to form Dutch liquid. This however is a valuable material.

Operating with pure ethylene, such as that made by the hydrogenation of acetylene, in the cell having a dissolved oxygen salt, pure glycol will be formed. But with pyrolytic gases containing ethylene, such as those obtained by cracking oils at low temperatures, there will usually be propylene and the butylenes present. These also make valuable glycols. Using pure ethylene in a cell having a chlorid as the electrolyte, similarly pure chlorhydrin, or chlorhydrin and Dutch liquid, will be produced. But with pyrolytic gases containing other olefins than ethylene, other chlorhydrins and chlorids may be obtained.

The present process may be used in connection with pure propylene or the butylenes in the manufacture of propylene glycol and propylene chlorhydrins, butylene glycols and butylene chlorhydrins.

In one modification of my invention, I may mount a gas circulating device on the cathode chamber C as well as on the anode chamber A, and in the former I may circulate acetylene. The acetylene acts as a depolarizer, combining with hydrogen to form

ethylene and reducing the current consumption. This ethylene may now be transferred to the anode chamber and oxidized to form glycol or chlorhydrin as the case may be. Running a cell for the production of caustic soda from brine in this manner, the current consumption is much reduced. In hydrogenating acetylene in this manner, it is useful to employ cathodes of nickel, cobalt and the like.

Apparatus of the type described and shown may also be used for non-electrolytic methods under the present invention. By omitting diaphragm 5, anode 27 and cathode 28, an oxidizing liquid may be fed in at a regulated rate through funnel 24 and connected parts. This oxidizing liquid may be a milk of bleaching powder. The rate of feed should be such as not to exceed the rate of solution of ethylene in the fluid of the chamber. Potassium permanganate solution may be fed in in the same manner. Many other oxidizing fluids may be similarly used. Or a charge of bleaching powder and water may be fed in through 24 and connected parts and then a mixture of carbon dioxid and ethylene fed in by pump 4. The carbon dioxid will decompose the bleaching powder forming hypochlorous acid which will unite with the ethylene to form chlorhydrin. Or the apparatus may be charged with bleaching powder and water containing a very small proportion of a cobalt salt and ethylene fed in and circulated as before. In the presence of a cobalt salt as a catalyst, bleaching powder gives up oxygen at a slow rate; and this oxygen will oxidize the ethylene. The rate may be controlled by controlling the amount of cobalt salt present and should be such that the rate of development of oxygen will not exceed the rate of solution of ethylene.

In another modification, the apparatus may be maintained at any suitable pressure and temperature and a mixture of ethylene and oxygen, or air, fed in and circulated, the liquid being kept charged with suspended or dissolved catalytic, such as platinum black, palladium, alkaline manganate, etc. The ethylene should be in excess of the oxygen at all times.

Using the rocker type of cell in electrolyzing brine, acetylene may be hydrogenated by contacting with the mercury in the soda compartment and the ethylene produced used as an anodic depolarizer in forming chlorhydrin.

Gaseous acetylenic hydrocarbons, such as acetylene, and gaseous diolefinic hydrocarbons, as well as gaseous olefins, may be advantageously oxidized by the present process.

In using weak ethylenic gases, such as those from cracking oil, from acetylene hydrogenated by nickel in the presence of a diluent gas, etc., if operating with a single electrolytic cell discontinuously, that is, with successive charges of gas introduced and circulated until the ethylene is absorbed, there is a periodic variation in the strength of current required. For example, with a fresh charge of coal gas containing, say, 45 per cent. ethylene and other olefins with the residue largely ethane, the absorption of the gas is at first relatively rapid, but as the ethylene disappears solution becomes slower; being for instance considerably slower when the richness in ethylene is reduced to 30 per cent. This may need a corresponding change in the current supply. By operating a number of cells in series, as regards the gas feed, each such cell venting gas into the next in series, this inconvenience may be overcome, each cell then operating with gases of a constant average content; the first, say with gas averaging 40 per cent., the next with gas averaging 30 per cent., and so on, each cell then having a constant current supply.

Gas of any desired degree of purity may however be obtained from lean ethylenic gas by scrubbing the latter by a countercurrent of spirits of turpentine, heavy oil or any other solvent for ethylene, exhausting the charged solvent by vacuum or heat, or both, and returning the exhausted solvent for fresh use with the gas to be scrubbed. The rich ethylene obtained by exhausting the charged oil may then be oxidized.

The manufacture of chlorhydrin is not specifically claimed in this case, it forming part of the matter of certain later but copending applications Serial Nos. 34,678, filed June 17, 1915; 35,505, filed June 22, 1915; 35,646, filed June 22, 1915; 65,983, filed Dec. 9, 1915; 107,564, filed July 5, 1916; 147,465, filed Feb. 8, 1917.

What I claim is:—

1. The process of preparing useful products which comprises submitting an unsaturated gaseous hydrocarbon to limited oxidation, such hydrocarbon being maintained in excess in the sphere of reaction during such oxidation.

2. The process of preparing useful products which comprises submitting a gaseous olefinic hydrocarbon to limited oxidation, such hydrocarbon being maintained in excess in the sphere of reaction during such oxidation.

3. The process of preparing useful products which comprises submitting a gas comprising ethylene to limited oxidation, such ethylene being maintained in excess in the sphere of reaction during such oxidation.

4. The process of making useful products which comprises subjecting a gaseous unsaturated hydrocarbon to limited anodic oxidation, such gaseous hydrocarbon being maintained in excess in the sphere of reaction during such oxidation.

5. The process of making useful products which comprises subjecting a gaseous olefinic hydrocarbon to limited anodic oxidation.

6. The process of making useful products which comprises subjecting a gas comprising ethylene to limited anodic oxidation.

7. The process of making useful products which comprises subjecting a gaseous unsaturated hydrocarbon to limited anodic oxidation with a sulfate electrolyte, such gaseous hydrocarbon being maintained in excess in the sphere of reaction during such oxidation.

8. The process of making useful products which comprises subjecting a gaseous olefinic hydrocarbon to limited anodic oxidation with a sulfate electrolyte.

9. The process of making useful products which comprises subjecting a gas comprising ethylene to limited oxidation with a sulfate electrolyte.

10. The process of making useful products which comprises electrolyzing sodium sulfate solution in the presence of a gaseous unsaturated hydrocarbon as a depolarizer.

11. The process of making useful products which comprises electrolyzing sodium sulfate solution in the presence of a gaseous unsaturated hydrocarbon as an anodic depolarizer.

12. The process of making useful products which comprises electrolyzing sodium sulfate solution in the presence of a gaseous olefinic hydrocarbon as an anodic depolarizer.

13. The process of making useful products which comprises electrolyzing sodium sulfate solution in the presence of a gas comprising ethylene as an anodic depolarizer.

14. In the electrolysis of solution of salts, the process which comprises electrolyzing a solution of a suitable salt in a divided cell, hydrogenating acetylene in the cathode compartment to produce ethylene and transferring the ethylene to the anode compartment to act as a depolarizer and produce chlorhydrin.

15. In the oxidation of unsaturated gaseous hydrocarbons in aqueous solution, the process which comprises maintaining in contact with such solution an oily solvent for such hydrocarbon while passing a current of such hydrocarbon through such solution.

16. In the oxidation of unsaturated gaseous hydrocarbons in aqueous solution, the process which comprises maintaining in contact with such solution a substance having the power of physically absorbing such hydrocarbon while passing a current of such hydrocarbon through such solution.

17. In the anodic oxidation of gaseous hydrocarbons, the process which comprises establishing an electrolytic current through a suitable electrolyte, and transmitting a current of such gaseous hydrocarbon through the electrolyte while maintaining in contact with said electrolyte an oily fluid having a solvent power for said gaseous hydrocarbon.

18. In the oxidation of ethylene, the process which comprises supplying ethylene gas under pressure to an aqueous liquid wherein oxidizing conditions are maintained in such manner as to maintain an excess of ethylene in the sphere of reaction at all times.

19. In the oxidation of ethylene the process which comprises supplying gas comprising ethylene under pressure to a closed chamber containing a body of aqueous liquid wherein oxidizing conditions are maintained, and causing a cyclic circulation of the gas so supplied through said body of liquid.

20. In the oxidation of olefinic gases, the process which comprises progressively developing oxidizing influences in a body of aqueous liquid and supplying dissolved olefinic gas to such liquid at a rate sufficiently rapid to maintain an excess of dissolved gas at all times during the oxidation.

21. In the oxidation of ethylene, the process which comprises progressively developing oxidizing influences in a body of aqueous liquid and supplying dissolved ethylene to such liquid at a rate sufficiently rapid to maintain an excess of dissolved ethylene at all times during oxidation.

22. In the treatment of difficultly soluble gases in solution, the process which comprises establishing reactive conditions in a body of liquid in a suitable chamber, supplying gas to be treated to said chamber and establishing a cyclic circulation of said gas independent of the supply thereof from a point above the liquid body to and through such body.

23. In the oxidative treatment of difficultly soluble gases in solution, the process which comprises establishing reactive oxidizing conditions in a body of liquid in a suitable chamber, supplying gas to be treated to said chamber and establishing a cyclic circulation of said gas independent of the supply thereof from a point above the liquid body to and through said body, said circulation being at a sufficiently rapid rate to maintain said body vesicular with said gas.

24. In the depolarization of electrolytic cells, the process which comprises supplying a feed of depolarizing gas to such a cell while maintaining an independent cyclic circulation of said gas through liquid in said cell, said circulation being sufficiently rapid to maintain said liquid in a foamy state.

25. In the manufacture of solvents, the process which comprises electrolyzing a liquid with a suitable anode and cathode,

supplying a feed of gas comprising a gaseous olefin and producing a rapid cyclic circulation of such gas through the electrolyzing fluid in the vicinity of the anode.

26. In the manufacture of solvents, the process which comprises electrolyzing a liquid with a suitable anode and cathode, supplying a feed of gas comprising ethylene and producing a rapid cyclic circulation of such gas through the electrolyzing fluid in the vicinity of the anode.

27. In oxidizing apparatus, a closed vessel, means for electrolyzing liquid therein, means for supplying gas thereto, means for removing waste gas therefrom and means for producing an independent cyclic circulation to gas within such vessel.

28. In oxidizing apparatus, a closed vessel, means for electrolyzing liquid therein, means for supplying gas thereto, means for removing waste gas therefrom and means for producing an independent cyclic circulation of gas within such vessel, such means comprising a fan having an inlet in the top of said vessel and an outlet conduit terminating in its base.

29. In an electrolytic apparatus, a closed cell provided with an anode and a cathode, means for feeding gas to said cell, means for withdrawing waste gas from such cell and independent means for producing cyclic circulation of gas within such cell.

30. In an electrolytic apparatus, a closed cell provided with an anode and a cathode, means for feeding gas to said cell, means for withdrawing waste gas from such cell and independent means for producing cyclic circulation of gas within such cell, such means comprising a fan having an inlet in the top of said cell and an outlet conduit terminating in its base.

31. In the manufacture of useful products, the process which comprises submitting an unsaturated hydrocarbon to limited oxidation, and during said oxidation and while supplying hydrocarbon to the reaction chamber continuously maintaining therein oxidizing conditions.

32. The process of manufacturing useful products which comprises producing a gaseous mixture containing an olefin and treating said mixture to produce an addition compound of said olefin containing at least one alcohol radical.

33. The process which comprises producing a gaseous mixture containing a gaseous olefin and flowing said gas in intimate contact with an aqueous solution capable of delivering an alcohol radical, whereby a substantial proportion of the olefin reacts with a portion of said solution to form an addition compound containing at least one alcohol radical.

In testimony whereof, I affix my signature in the presence of two subscribing witnesses.

K. P. McELROY.

Witnesses:
JOHN H. SIGGERS,
H. SCHOENTHAL.

K. P. McELROY.

PROCESS OF OXIDIZING HYDROCARBONS.

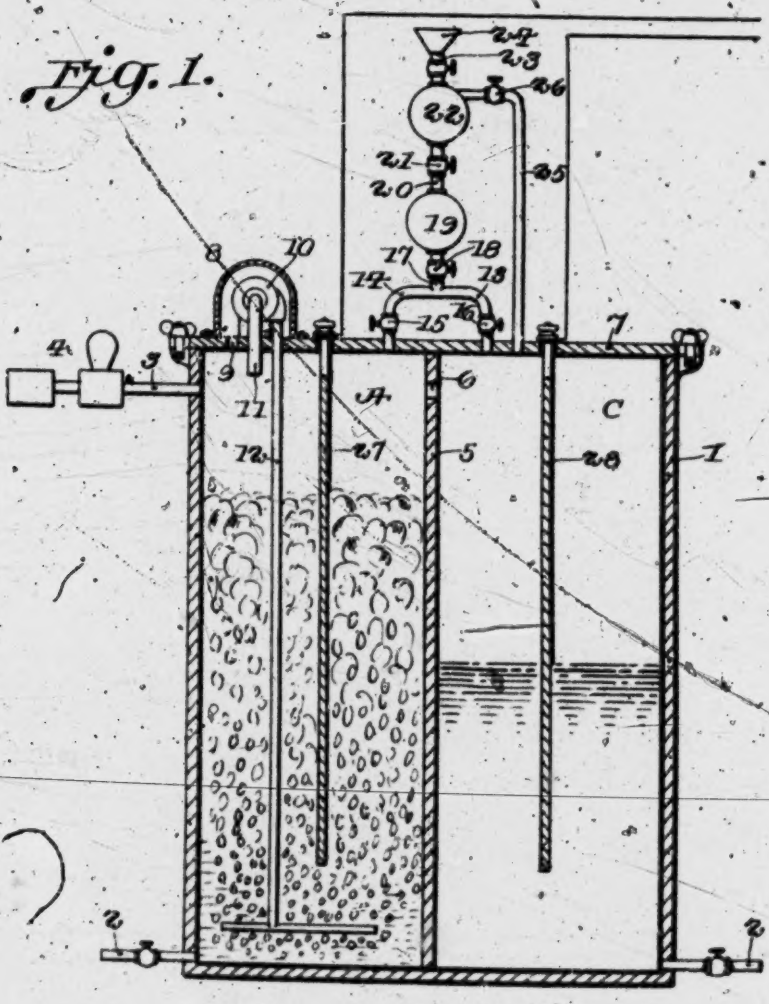
APPLICATION FILED JUNE 26, 1917.

1,308,797.

Patented July 8, 1919.

2 SHEETS—SHEET 1.

Fig. 1.



Witness

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PROCESS OF OXIDIZING HYDROCARBONS.

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1,308,797.

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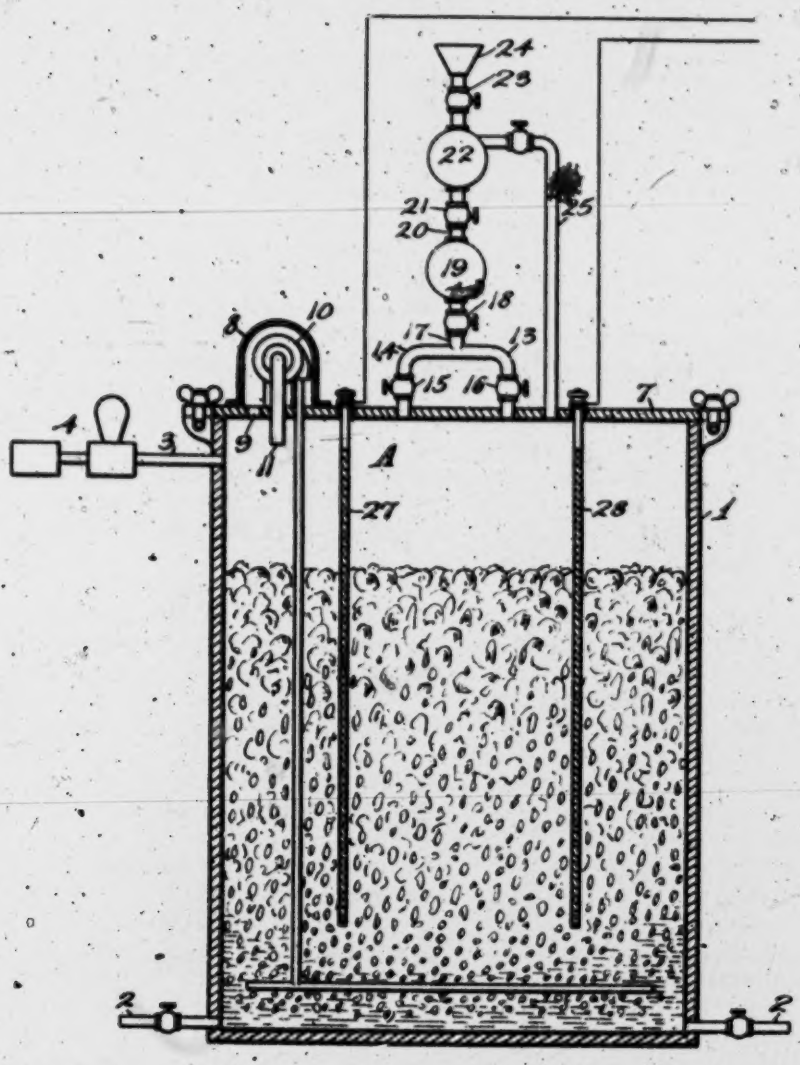
2 SHEETS—SHEET 2.

Fig. 2.



Inventor:
Karl P. McElroy
By Philipp Sawyer Rice & Kennedy

UNITED STATES PATENT OFFICE.

KARL P. McELROY, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR TO CHEMICAL DEVELOPMENT COMPANY, A CORPORATION OF MAINE.

PROCESS OF OXIDIZING HYDROCARBONS.

1,308,797. Specification of Letters Patent. Patented July 8, 1919.

Application filed June 26 1917. Serial No. 177,028.

To all whom it may concern:

Be it known that I, KARL P. McELROY, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Processes of Oxidizing Hydrocarbons, of which the following is a specification.

This invention relates to processes of oxidizing hydrocarbons, and it comprises a method of producing useful products from unsaturated hydrocarbons, and particularly from olefin hydrocarbons, wherein such a hydrocarobon is submitted to direct oxidation in solution with the aid of a catalyst, and particularly a metal of the platinum group, oxygen for oxidation being supplied in the form of an oxidizing salt or other suitable source of oxidation.

There are various oxygen-containing or oxidized derivatives of the olefins, such as the glycols, the chlorhydrin, glycol esters, glycol ethers, olefin oxids, etc., having properties which would render them useful in various arts if such derivatives could be produced by a method sufficiently simple, cheap and ready to make them commercially available. At present however these bodies are not available for technical purposes being merely laboratory curiosities, made when wanted for scientific purposes by indirect, cumbrous and wasteful methods. For example, ethylene, ordinarily made from alcohol, is converted into a dihalid and this is then saponified or esterified to replace the halogen by other groups. Saponification and esterification are both operations attended with some difficulty and giving small yields since the dihalids are stable, little reactive substances. Ethylene glycol, for example, is usually made for scientific purposes by converting ethylene, produced from alcohol, into the dibromid, converting the dibromid into an acetic ester and finally saponifying the latter by alkali.

It is an object of the present invention to obtain these potentially valuable oxidized bodies from ethylene and other olefins in the gaseous condition by a direct limited oxidation under controlled conditions. Ethylene which is typical of the other olefinic gases is a readily oxidizable substance, but, being endothermerically constituted, oxidation is attended with the liberation of much energy and is apt to be too far going, and furthermore the direct products of its limited oxidation, ethylene oxid, glycol and chlorhydrin are themselves also readily oxidizable. Ethoylene oxid, which is the first product of oxidation, is particularly sensitive; glycol is more resistive.

I have found however that under suitable conditions the oxidation of the olefins, for example, ethylene can be limited and regulated to the desired degree and that such a limited oxidation of an olefin such as ethylene itself is, so to speak, preferential over the further oxidation of these proximate oxidation products; that is, so long as unattacked ethylene remains in the sphere of reaction the oxidation merely goes to the first stage and the ethylene exercises a protective action shielding the proximate products from further attack.

Dilution is useful in the limited oxidation of ethylene in the gaseous state by chlorin and steam, steam being best present in ample amount, and by oxygen in the presence or absence of catalytics, such as platinum black, labile oxids, nitrous vapors, etc.; and in the treatment of ethylene dissolved in various liquids; advantageously an aqueous liquid. The solubility of ethylene in most aqueous liquids is relatively small so that even a saturated solution thereof is still actually, as regards the ethylene, very dilute and the heat of oxidation becomes a limited quantity readily taken up and controlled by the liquid solvent. In fact the solubility of ethylene as ethylene in most aqueous liquids is so small as compared with that of many of the ordinary oxidants that in oxidizing in aqueous solutions special means must ordinarily be adopted to maintain the ethylene solution replenished with the gas and prevent the chance of an excess of such oxidant existing at any time during the reaction.

Several expedients to this end may be employed. One is an increase in pressure which causes a concomitant increase in the solubility of ethylene. With 15 pounds gage pressure, the amount which can be held in solution and drawn upon for reaction is about doubled. Another is quicker replenishment of the supply of dissolved ethylene by filming the liquid or otherwise increasing the area of contact between liquid and gas. Vigorous agitation of the liquid to prevent localized changes in the relative concentration of ethylene and oxidant is desirable. The

increase in area of contact and the agitation may be simultaneously attained and a number of other desirable results secured by causing a cyclic circulation of the gas to, through and back to the reaction liquid; that is with a reaction chamber having a gas feed and means for withdrawal of waste gas there may be provided additional means capable of continuously taking gas from above the body of liquid and again bubbling it therethrough. Advantageously there may be employed a fan or blower. The fan means may be, and advantageously is, speeded up so as to maintain an emulsion of liquid and gas.

Another expedient often useful is to maintain porous, absorptive materials, such as charcoal, coke, boneblack, platinum black, etc., suspended in the liquid in which the oxidant is contained or in which it is being developed to absorb gas and re-deliver it to the liquid. Such bodies may, and usually do, superadd a useful catalytic effect in aiding oxidation. For example, ethylene and air may be supplied to a hot liquid holding platinum black or colloidal palladium or the like in suspension.

Where the unsaturated hydrocarbon is ethylene it may be produced from any of the usual sources, as by dehydrating alcohol, by hydrogenating acetylene or by destructive distillation or cracking of coal, oil or other carbonaceous bodies. Using ordinary coal gas as a source of olefins, such as ethylene, it is useful to extract the ethylene and other olefinic gases by means of wash oil. From the wash oil, the olefinic gases may be separated in a concentrated state by heating or vacuum.

By proper precaution petroleum oil may be cracked down to form gas mixtures rich in ethylene, propylene and the butylenes; and useful in the present invention. Acetylene may be hydrogenated to ethylene by catalytics or electrolytically.

Many oxidants may be used in the present invention, such as oxidizing salts, like permanganates, chromates, vanadates, arsenates, etc., in acid, alkaline or neutral baths. Peroxidized bodies, such as hydrogen peroxid, barium peroxid, calcium peroxid, sodium peroxid, perborates, persulfates, etc., may also be used. Manganese binoxid and an acid may be employed. Bleaching powder containing a trace of cobalt or other catalytic causing an evolution of nascent oxygen may be used. When ethylene chlorhydrin is desired, the bleaching powder may be acidulated with a weak acid.

With many of these oxidants, the addition of the same or the development of its oxidizing influence should be proportionate to the rate of solution of ethylene; there should always be unattacked ethylene in the sphere of reaction.

The drawings illustrate, diagrammatically, apparatus which is suitable for carrying out the invention. Figure 1 shows apparatus with a diaphragm and Fig. 2 shows another type of apparatus not employing a diaphragm.

The invention is particularly intended to be carried out in an electrolytic cell, and in this case any suitable electrolyte may be used, such as salt (sodium chlorid), sodium sulfate, phosphates, borates, etc. Electrolysis may be in a divided cell, as shown in Fig. 1, that is a cell having a diaphragm separating the cell into an anode compartment and a cathode compartment; or in an undivided or diaphragmless cell, such as those used in electrolyzing sodium chlorid solutions to make hypochlorites and other oxidized chlorin-containing products, as shown in Fig. 2. The results differ with the type of cell. With a divided cell, electrolysis necessarily develops oxidizing conditions and acidity in the anode chamber and reducing conditions and basicity in the cathode chamber. In such a cell using a chlorid electrolyte, part of the chlorin developed goes into combination with the ethylene, etc., to form chlorhydrins. Using such a cell, the anode liquor and cathode liquor may be ultimately reunited to form a neutral liquid from which the oxidation products of the ethylene, etc., may be regained. With an undivided cell, the electrolyte remains neutral but oxidizing conditions develop while hydrogen escapes. If the electrolyte contains an oxygen salt such as a sulfate, borate, etc., the oxygen mostly develops as such and for economy it must be used (that is taken up by the olefin) as fast as it is produced since these salts themselves do not ordinarily oxidize to any great extent; that is there is not much tendency, except under special conditions, to form persulfates and the like. The use of carrier oxidants, such as chromium salts, iron salts, cerium salts, manganese salts, etc., however may be resorted to since such salts are able to take up and redeliver oxygen. With a chlorid salt, such as sodium chlorid, in an undivided cell, the circumstances are different since the net effect of development of oxidation is then a production of oxidizing salts such as hypochlorites and chlorates. These are oxidizing salts which may be used to redeliver oxygen with the aid of suitable catalysts. Therefore any oxygen not at once taken up by the olefin may be, so to speak, stored. With an undivided cell the solution, as stated, remains neutral and these oxidized chlorin products have, in neutral solution, no violent oxidizing action. Any suitable anode metal and cathode metal may be used.

With salt (sodium chlorid) and other halogen compounds in a divided cell, on oxidizing ethylene in the anode chamber, the product is generally ethylene chlorhydrin

which may be saponified to glycol with the soda accumulating in the cathode compartment. In forming chlorhydrin, chlorin goes into organic combination and the net result is the formation and accumulation in the cathode chamber of an excess of alkali corresponding to the amount of chlorin so removed. On saponification (removal of the chlorin from organic combination), with this excess of alkali a neutral liquor is once more formed.

In electrolyzing a salt solution in an undivided cell in the usual ways as stated the salt may be in effect oxidized with formation of hypochlorites and chlorates but the neutrality of the solution does not change. If this electrolysis be performed in the presence of olefins, etc., the net result is the formation of glycols; and it is immaterial here whether this result is a direct oxidation of the ethylene in preference to the salt, is a preliminary oxidation of the salt to hypochlorite, etc., with transference of oxygen from the oxidized salt to the ethylene, or is a preliminary formation of chlorhydrin with subsequent saponification to glycol by the alkali simultaneously formed. In working with the undivided cell and a sodium chlorid solution it is better to use oxygen carrying catalysts, such as cobalt salts, or platinum group metals, such as platinum, palladium, etc.

In the accompanying illustration I have shown, more or less diagrammatically, a generalized type of apparatus which may be used in many of the reactions described herein. In this showing reference character 1 indicates a vessel which may be made of any suitable materials, such as sheet metal, appropriately coated with a resistant inner lining. This is advantageously built so as to withstand internal pressure. It is provided with valved draw-off outlets 2 for removing liquid. It is also provided with inlet 3, supplied by pressure pump 4, through which an olefinic gas, or mixture of such gas with any other gas desired, may be supplied under any convenient pressure. As shown, the vessel is particularly adapted for electrolytic purposes and may or may not be provided with a diaphragm, shown in dotted line as 5. Such a diaphragm may be of any usual material and divide the cell into an anode chamber A and cathode chamber C. This diaphragm is advantageously perforated above the liquid level as at 6 to allow equalization of gas pressure on the two sides. This diaphragm may be, and in the present specific modification of my invention advantageously is, omitted. The vessel is provided with cover 7 which may be clamped on in any suitable manner. This cover carries hood 8 having communication with the chamber of the vessel through orifice 9. This equalizes the chamber pressure with that of the hood 8. Within this hood is mounted any simple type of blower or pump, shown here as rotary blower 10. This blower has communication with the gas space within the chamber at 11 and is provided with conduit 12 extending nearly to the bottom of the vessel. The lid may also be provided with two conduits 13 and 14 placed on each side of the diaphragm and valved respectively at 15 and 16. These two conduits unite as conduit 17, valved at 18, which expands into chamber 19. Above this chamber is a length of piping 20, valved at 21, and connecting with another chamber 22, above which is valve 23 and hopper or funnel 24. Equalizing pipe 25, valved at 26, allows equalization of pressure. This last described device enables equalization of gas pressure with that of the chamber by opening appropriate valves; and it also allows liquid to be fed to either side of the diaphragm and without disturbance of the chamber pressure. For example, a liquid may be fed into 24, and, valves 26 and 21 being closed, may be fed into 22 by opening valve 23. By now closing valve 23 and opening 26 and 21, (valve 18 being normally open) the liquid may be caused to pass down into 19 and thence by 16 or 15, the liquid may be discharged on either side of the diphragm.

Anode 27 and cathode 28 may be of any suitable metal or structure adapted to a particular electrolysis.

In one embodiment of the present invention using electrolytic oxidation the diaphragm 5 is omitted, allowing free communication between the liquids in the two compartments. The vessel is charged with a solution of sodium chlorid of such strength as to give good conduction. Ethylene, or gas containing ethylene, may now be introduced into the apparatus by means of pump 4 at any pressure desired, say, 4 or 5 atmospheres. Upon now starting blower 10 into operation, the liquid is kept thoroughly saturated with dissolved ethylene. It is advantageous to run this pump or blower at such a rate that the liquid is maintained as more or less of an emulsion of gas and liquid; as a foamy mass. Upon now passing a current through the device in such a manner that 27 becomes the anode, the ethylene is oxidized to glycol which goes into solution. The oxidizing influence developed at the anode whether this be due to nascent chlorin or oxygen or oxidation products of chlorin or of the chlorid, oxidizes the dissolved olefins. This oxidation may be aided by the presence of catalysts which superadd a function of absorbing gas and redelivering to the liquid. In the present embodiment of my invention I use platinum group metals as this catalyst. Platinum black or colloidal palladium may be used.

It is best to limit the rate of development of the oxidizing action at the anode according to the rate of solution of the ethylene so that an excess of ethylene shall remain in the solution at all times where a continuous operation is used. This is for the reason that should the solution temporarily become exhausted of ethylene while oxidation is still being developed there is the danger of oxidation of glycol to form glycolic acid, etc. For this reason in continuous operation the current should be regulated in correspondence with the supply of dissolved ethylene. The apparatus may be run discontinuously, a charge of ethylene, or gas containing the same, as for example, a pyrolytic oil gas containing say 40 or 50 per cent. of ethylene and other olefins, being introduced and the pump 10 being kept in operation until the ethylene of the charge has become absorbed and oxidized. At this time the current may be interrupted and waste gas vented through 14. Another charge of ethylene, or gas containing the same, may now be introduced and so on until the concentration of glycol in the solution becomes as high as may be desired. Where no diaphragm is used there is no substantial change in the solution as regards alkalinity or acidity. If a neutral salt solution is used at the beginning it is neutral at the end. Where the supply of ethylene is sufficient and the catalyst is of suitable character there will be no oxidized chlorin compounds at the end of the operation. The final result therefore will be a neutral saline solution containing glycol; and from this solution glycol may be isolated by ways similar to the ways of recovering glycerin from salt lyes, its properties, as well as its uses, being very similar to those of glycerin. Like glycerin it is a dense, high boiling liquid which however can be blown over readily with steam. The anode may be of platinum, carbon or lead. The fluid surrounding the anode may contain, in addition to the catalyst, a carrier oxydant, such as a chromium salt, a cerium salt, a manganese salt, etc. A little platinum black, palladium or the like may be kept suspended in the liquid. Other bodies having an absorbent action but not so much catalytic action, such as charcoal and bone-black may be used. But I regard the platinum group metals, which have both absorbent and catalytic properties, as the best for the present purposes.

Using salt solution as the electrolyte, the cell may be worked under conditions analogous to those used in making hypochlorites. In such an event, the cathode should be of small effective area to give a high current density and permit escape of hydrogen without reduction of oxidized chlorin compounds. It is desirable to keep the temperatures low, ordinary temperature being suitable, and to maintain an excess of ethylene dissolved in the solution.

Operating with pure ethylene, such as that made by the hydrogenation of acetylene, in the cell, pure glycol will be formed. But with pyrolytic gases containing ethylene, such as those obtained by cracking oils at low temperatures, there will usually be propylene and the butylenes present. These also make valuable glycols. The present process may be used in connection with the pure propylene or the pure butylenes in making propylene glycol and butylene glycols.

Apparatus of the type described and shown may also be used for non-electrolytic methods under the present invention. By omitting diaphragm 5, anode 27 and cathode 28, an oxidizing liquid may be fed in at a regulated rate through funnel 24 and connected parts. This oxidizing liquid may be a milk of bleaching powder. It contains hypochlorite of calcium which may be regarded as an oxidation product of calcium chlorid. It may be made in an electrolytic cell in the same way as is described for sodium hypochlorite but ordinarily is made by producing chlorin in a suitable cell and contacting it with lime elsewhere. Bleaching powder and water may be fed in through 24 until the apparatus is charged to a sufficient extent. In this charge may be a very small proportion of a cobalt salt. Ethylene may then be fed in and circulated as before. In the presence of a cobalt salt as a catalyst hypochlorite solutions, such as those made from bleaching powder, give up oxygen at a slow rate and this oxygen oxidizes the ethylene. The rate may be controlled by controlling the amount of cobalt salt or other catalyst present and should be such that the rate of development of oxygen does not exceed the rate of solution of ethylene.

The apparatus may be maintained at any suitable pressure and temperature. Ethylene or a mixture of ethylene and air may be fed in and circulated. The liquid may be kept charged with suspended or dissolved catalytics, such as platinum black, palladium, alkaline manganates, etc. The ethylene in solution should always be in excess to cause oxidation to affect it rather than its oxidation products.

In using weak ethylenic gases, such as those from cracking oil, from acetylene hydrogenated by nickel in the presence of a diluent gas, etc., if operating with a single electrolytic cell discontinuously, that is, with successive charges of gas introduced and circulated until the ethylene is absorbed, there is a periodic variation in the strength of current required. For example, with a fresh charge of oil gas containing, say, 45 per cent. ethylene and other olefins with the

residue largely ethane, the absorption of the gas is at first relatively rapid, but as the ethylene disappears solution becomes slower; being for instance considerably slower when the richness in ethylene is reduced to 30 per cent. This may need a corresponding change in the current supply. By operating a number of cells in series, as regards the gas feed, each such cell venting gas into the next in series, this inconvenience may be overcome, each cell then operating with gases of a constant average content; the first, say with gas averaging 40 per cent., the next with gas averaging 30 per cent. and so on, each cell then having a constant current supply.

Gas of any desired degree of purity may however be obtained from lean ethylenic gas by scrubbing the latter by a countercurrent of spirits of turpentine, heavy oil or any other solvent for ethylene, exhausting the charged solvent by vacuum or heat, or both, and returning the exhausted solvent for fresh use with the gas to be scrubbed. The rich ethylene obtained by exhausting the charged oil may then be oxidized.

In the specific embodiment of my invention claimed in the present case the liquid forming the electrolyte is a solution of common salt and electrolysis is in an undivided cell. In this liquid oxidation with or without development of oxidized chlorids or oxidized chlorin compounds occurs. The liquid is kept saturated with ethylene or another olefin; or with the mixed olefins of oil gas and absorption and oxidation are aided by the presence of an absorbent and catalytic body which is best one of the platinum group metals, such as platinum or palladium, though other catalysts may be used. The oxidized chlorid or oxidized compound of chlorin may however be produced elsewhere, and supplied to a separate reaction chamber and there treated with the olefin. Whether the oxidized chlorin compound be developed, so to speak, *in situ*, or whether it be supplied from another source, the solution however should be kept as nearly as may be saturated with dissolved ethylene or olefins during the action. In the absence of an excess of olefin, such carrier catalysts or oxidizing catalysts as platinum black, palladium, etc., may carry the oxidation further than is here desired.

What I claim is:—

1. The process of making glycols which comprises electrolyzing a chlorid solution in a diaphragmless cell in such manner as to oxidize said chlorid, and maintaining the electrolyte saturated with a gaseous olefiin in the presence of an oxygen carrying catalyst.

2. The process of making glycols which comprises electrolyzing sodium chlorid in a diaphragmless cell in such manner as to oxidize said chlorid, and maintaining the electrolyte saturated with a gaseous olefin in the presence of an oxygen carrying catalyst.

3. The process of making glycols which comprises electrolyzing a chlorid solution in a diaphragmless cell in such manner as to oxidize said chlorid, and maintaining the electrolyte saturated with oil gas in the presence of a platinum group metal as a catalyst.

4. The process of making glycols which comprises electrolyzing sodium chlorid in a diaphragmless cell in such manner as to oxidize said chlorid, and maintaining the electrolyte saturated with a gaseous olefin in the presence of a platinum group metal as a catalyst.

5. The process of making glycols which comprises maintaining a solution of an oxidized chlorid salt saturated with a dissolved olefin in the presence of a platinum group metal as a catalyst.

6. The process of making glycols which comprises maintaining a solution of an oxidized chlorid salt saturated with oil gas in the presence of a catalyst.

7. The process of making glycols which comprises maintaining a solution of an oxidized chlorid salt saturated with oil gas in the presence of a platinum group metal as a catalyst.

8. The process of making glycols which comprises agitating a solution containing a dissolved oxidized chlorin salt with oil gas in the presence of a catalyst.

9. The process of making glycols which comprises agitating a solution containing a dissolved oxidized chlorin salt with oil gas in the presence of a platinum group metal as a catalyst.

10. The process of oxidizing gaseous olefins which comprises emulsifying such olefins with a chlorid electrolyte during electrolysis and in the presence of a catalyst.

11. The process of oxidizing gaseous olefins which comprises emulsifying such olefins with a liquid containing products of the electrolytic oxidation of a chlorid and also containing a platinum group metal as a catalyst.

12. The process of oxidizing gaseous olefins which comprises emulsifying such olefins with a liquid containing a salt of an oxygenated acid of chlorin and also containing a platinum group metal as a catalyst.

13. The process of oxidizing gaseous olefins which comprises electrolyzing a chlorid electrolyte in a diaphragmless cell and emulsifying the electrolyte with such olefins in the presence of a platinum group metal as a catalyst.

14. The process of making useful products from oil gas which comprises emulsifying oil gas with a chlorid electrolyte during electrolysis and in the presence of a catalyst.

15. The process of oxidizing gaseous olefins which comprises electrolyzing a chlorid electrolyte in a diaphragmless cell and emulsifying the electrolyte with oil gas in the presence of a platinum group metal as a catalyst.

16. The process of making glycols, which comprises bringing an olefin in gaseous state in contact with a solution of an oxidized halid salt in the presence of a platinum group metal as a catalyst.

17. In the process of producing oxidation products of the olefins, the step which consists in subjecting an olefin to the action of an oxidizing agent in the presence of a catalyst while maintaining the olefin in excess.

In testimony whereof, I affix my signature.

K. P. McELROY.

DEFENDANT'S EXHIBIT 91

JOURNAL
OF
THE FRANKLIN INSTITUTE
Devoted to Science and the Mechanic Arts
Vol. 194 July, 1922 No. 1

CATALYSIS AND CATALYTIC AGENTS IN CHEMICAL PROCESSES.

BY

HUGH S. TAYLOR.

* * *

Each class of reaction has its own class of catalytic agent and each of these classes may similarly be circumscribed as to members. Thus, for example, it may be seen that as catalysts for oxidation processes, oxides are an important class of catalysts. Of the oxide class, however, it is remarkable that only a limited number function at all prominently as catalysts. The oxides of well-defined stability are conspicuously absent. The oxides of the alkali metals, to a less extent those of the alkaline earths, definite irreducible oxides such as magnesium oxide and aluminium oxide are not frequently to be found among the oxide catalysts of oxidation. On the other hand, the labile oxides such as those of iron, copper, manganese, silver, vanadium, tungsten, molybdenum uranium, chronium, cobalt and cerium are frequently to be noted in a systematic study of such oxide catalysts of oxidation. * * *

Vol. II

TRANSCRIPT OF RECORD

Supreme Court of the United States

OCTOBER TERM, 1941

No. 680

U. S. INDUSTRIAL CHEMICALS, INC., PETITIONER,

vs.

CARBIDE AND CARBON CHEMICALS CORPORATION

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE FOURTH CIRCUIT

PETITION FOR CERTIORARI FILED OCTOBER 4, 1941.

CERTIORARI GRANTED NOVEMBER 10, 1941.

United States Circuit Court of Appeals

FOR THE FOURTH CIRCUIT

No. 4774

U. S. INDUSTRIAL CHEMICALS, INC.,
Defendant-Appellant

v.

CARBIDE AND CARBON CHEMICALS CORPORATION,
Plaintiff-Appellee

APPEAL FROM THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF MARYLAND

APPENDIX TO PLAINTIFF-APPELLEE'S BRIEF

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United States Circuit Court of Appeals

FOR THE FOURTH CIRCUIT

U. S. INDUSTRIAL CHEMICALS, INC.,
Defendant-Appellant

v.

CARBIDE AND CARBON CHEMICALS CORPORATION,
Plaintiff-Appellee.

No. 4774.

APPENDIX TO PLAINTIFF-APPELLEE'S BRIEF

Testimony of Reston Stevenson

[84]

* * * * *

Thereupon—

RESTON STEVENSON, a witness of lawful age, produced on behalf of the Plaintiff, having been first duly sworn according to law, was examined and testified as follows:

[85]

DIRECT EXAMINATION BY MR. WATSON:

Q. Please state your name, residence and occupation? A. My name, Reston Stevenson. I am professor of chemistry at the college of the City of New York. I reside in New York City, 585 West End Avenue.

Q. What has been your education and experience, Doctor Stevenson? I want your qualifications which enable you to explain the patent in suit.

[86]

A. I was born in Wilmington, North Carolina, in 1882. I graduated at the University of North Carolina, in 1902, with a Master's Degree in Chemistry in 1903; then went to Cornell University for two years as an Assistant Instructor in Chemistry, 1903, -4, and -5, where I also took graduate work in Chemistry. In 1905 to -6 I was Analytical Chemist for the General Chemical Company. I left then to go to the College of the City of New York. And I have been at the College of the City of New York ever since that time. And my position now is that of Professor of Chemistry there.

During the World War, the previous World War, I was commissioned as a captain, and I was detailed to work with the French chemists at the Sorbonne, and elsewhere, upon chemical warfare. A part of that work was upon a catalytic process of making ammonia, by synthesis catalytically from the elements. For this work and for other chemical warfare work that I did with the French I was decorated with the Legion of Honor. I left the Army at the end of the War, but I have recently been appointed a consultant for the Chemical Warfare Service of

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the United States Army.

I have given expert testimony in patent cases; and in three of these patent cases the processes were catalytic.

I am a member of the American Chemical Society, I am a member and Past Sectional Chairman of the Electro-

Chemical Society, and I am a member and Past President of the Chemistry Teachers' Club of New York City.

I have the degree of Ph.D. from Columbia University, which I took in the year 1908 upon Physical Chemistry as a major subject.

Q. Have you read, and do you understand, the patent in suit? A. I have read it, and I do understand it.

Q. Will you please refer to that and discuss the subject matter as disclosed therein, explaining the process, and so much of the general features of chemistry involved as may be necessary to an understanding of it.

The Court: And you may assume, Professor, that you are telling it to a freshman class that knows no chemistry, and therefore knows nothing about this subject.

[88]

A. This Lefort Patent deals with a chemical process in which the gases are caused to react under the influence of a surface catalyst. The gases are molecular oxygen having the formula O_2, signifying two atoms of oxygen drawing together to form a molecule, O_2, such as the oxygen in the atmospheric air; and the other gas that reacts is ethylene.

* * * * *

The ethylene is formula C_2H_4, but the formula given in more detail shows the carbon joined to two hydrogens, the other carbon to two hydrogens, and the double bond between each carbon's atoms, that is ethylene. Ethylene is a gas; and it has a faint odor, and it is inflammable.

The product of the reaction is ethylene oxide, and it will be observed that one oxygen atom is there in addition to the ethylene molecule that was there before. Ethylene oxide is C_2H_4O:

* * * * *

[89]

• • • • •

Here is a method that is used by chemists to represent this same thing. (Referring to models.) The carbon quite appropriately is black, and the hydrogen, inappropriately, is yellow. But there are others: Two hydrogens, and two more hydrogens. So ethylene is C_2H_4, and there is the double bond between the carbon atoms shown also, whereas in contrast, compare with that ethylene oxide, the red ball meaning the oxygen. And the difference is that one of these bonds has broken out, and has joined on to the oxygen. And the difference in formula is C_2H_4 and C_2H_4O.

• • • • •

[90]

• • • • •

The product ethylene oxide is a valuable one, not only in itself, but also as an intermediate for making a number of chemical substances of value. It is the base for making the permanent anti-freeze for automobile radiators. That is to say, the ethylene oxide is the intermediate, because using it as an intermediate it makes glycol; and glycol and water mixed together make the permanent anti-freeze for an automobile radiator, such as the Prestone brand. And this same glycol, with some water, is used as a cooling liquid in airplane engines.

And ethylene oxide is an intermediate for making a number of lacquer solvents. And it is used for the raw materials in diversified industries, such as air-conditioning, safety glass, the finishing of leather and textiles, and also in national defense.

The catalyst involved is a surface catalyst, which is a solid material, of extended surface, which by its presence and its contact with the gases causes and directs the desired chemical combination. The catalyst

[91]

itself takes no part in the chemical combination. That is to say, it takes no part in this sense, that the catalyst remains at the end of the reaction unchanged chemically and unchanged in amount, although it has caused a reaction to take place.

The first two lines of the patent in suit read, "This invention provides a specific and novel process for making ethylene oxide."

In 1931, the chemical compound ethylene oxide was not itself new; but the process is new, and the process is also specific, by which is meant, as will appear, that it makes ethylene oxide directly and without substantial amounts of such other products as would present difficulties of separation.

Lines 2 through 8 refer to the novel process as follows: "It essentially consists in causing ethylene to combine directly with molecular oxygen at temperatures of about 150 degrees to about 400 degrees Centigrade in the presence of a surface catalyst which favors the oxidation of ethylene to ethylene oxide under these conditions."

[92]

I shall refer later to a consideration of these lines.

This oxidation of ethylene to ethylene oxide is a chemical reaction which lines 17 through 20 expresses in symbols as follows:

I shall first read lines 17 through 20. This novel reaction may be expressed as: $2C_2H_4 + O_2 = 2CH_2\text{-}CH_2$ (with O bridging the two CH_2 groups).

Or, as shown here on the chart, this expression, which is called a chemical equation means two molecules of ethylene

plus molecular oxygen form two molecules of ethylene oxide.

The desirability of effecting this reaction was recognized over a century ago by the great French chemist, Berthelot, and he wrote this equation in an article that he published in 1882, and he calculated indirectly, using atomic weights that were prevalent at that time, the heat of reaction if the reaction could be made to occur, but he was careful to say that at his time there was no way of making that reaction occur, but you could start

[93]

with ethylene and arrive at ethylene oxide by a roundabout, indirect process involving several steps.

This inability to effect the direct addition of oxygen to ethylene to make ethylene oxide continued over the years, and in 1926 it was thus expressed in the book of Rideal and Taylor on catalysis at page 213 (reading):

> "The investigations on the direct oxidation by means of oxygen gas of a number of organic substances has indicated that the process can not take place by means of simple addition, for example, 2X plus O_2 gives 2XO, where X is the substance undergoing oxidation to the stable oxide XO."

Expressing this as applied to ethylene, it reads:

> "2 ethylene plus O_2 will not make 2 ethylene oxide."

The patent discloses that this is no longer an impossibility but a fait accompli.

In the equation that we have written here there is no mention of the surface catalyst; because a chemical equation represents chemical changes, for calculating the relative amounts of reactants and products,

[94]

whereas the catalyst does not change in either amount or chemical nature through the reaction; the presence of the catalyst may be indicated by placing the word "catalyst" over the arrow (indicating on chart).

And so we have, then, the two molecules of the ethylene plus the molecule of oxygen, formed in the presence of the catalyst, two molecules of ethylene oxide.

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[100]

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Doctor Stevenson, can you give me an indication of how many compounds of ethylene and oxygen there are?

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[101]

The Witness: If I restrict it for simplicity, starting with one molecule of ethylene reacting with oxygen, there are about seventeen of them that are well known that you could have, could make and they are given on this table here and to make it very brief I will not follow the alphabetical order but will call them off. There is acetylene and oxalic acid and glycolic acid, formaldehyde, glyoxalic acid, alcohol, ethylene oxide, carbon monoxide, carbon dioxide, water, formic acid, acetic acid, dehydroxyethylene, ketene, glyoxal, acetaldehyde, ethylene peroxide, glycolic aldehyde, and those represent what you could get from the oxidation.

By Mr. Watson:

Q. How is ethylene oxide made by this indirect roundabout method you spoke of? A. The indirect method is

shown in this tabulation and is known as the chlorhydrin method in which you have the ethylene react with hypochlorous acid, making ethylene chlorhydrin and afterwards you have the ethylene chlorhydrin reacting with an alkali such as sodium hydroxide and making ethylene oxide. In the equation as written here H_2O has been omitted, it is carried in water.

Q. Is that a catalytic method?

[102]

A. No, that was not a catalytic method, as you can see, because the hypochlorous acid did not remain unchanged chemically and in amount at the end of the reaction. It was changed chemically into the chlorhydrin and afterwards into sodium chloride and as to the amount that was used up and so it was not catalytic and known as purely chemical equation.

Q. Refer to the patent in suit, lines 1 to 8. Is that a catalytic method? A. Lines 1 to 8 I need not read again because I have read them and that states that it is a catalytic method. It mentions the surface catalyst that is there and it also mentions that it is a combination of the surface catalyst and the temperature; the two are mentioned as bringing about the reaction.

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[103]

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A. That is a unique reaction in my opinion because so far as I know this was the first time that anyone had taken ethylene and had made that second bond open up and put on one atom of oxygen. In particular, it was the

[104]

first time that that had been done under the influence of a catalyst in particular, but in general I think it is unique also. I think it is somewhat comparable to the adding of hydrogen to ethylene by Sabatier and Senderens, where they put on two hydrogens to make the saturated compound and that is known as the Sabatier Senderens equation as shown in this little tabulation that is published by the Van Nostrand and Company and it has organic type reactions with their originators' names and you find many of the great names of chemistry in this, such as Grignard. You find the Sabatier Senderens reaction there and that is supposed to be sufficiently described there when they say "Passing vapors of substances to be reduced mixed with hydrogen over finely divided nickel or certain other metals (catalyzers) at an optimum temperature.

[105]

A. Ethylene oxide is a liquid but it is a very volatile liquid. It boils at about ten degrees centigrade and this room must be about thirty degrees centigrade, maybe thirty-five, and it is a very volatile, colorless liquid and it has an ethereal odor.

[106]

Its real use is, it is an intermediate, as we say in chemistry, and starting with that you can make many chemicals of value.

[108]

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It makes a number of lacquer solvents. And that is to say, those are called glycol ethers, which means that the ethylene oxide, which is a base, is combined with some organic alcohol. One of those glycol ethers is "Cellosolve."

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[109]

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This patent states that ethylene oxide is formed, and it is a specific reaction. It gives you ethylene oxide; but without the formation of these other substances that would involve difficulty in separation,

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Of course, the oxygen of the air is molecular oxygen as it occurs in the air, and the air commonly contains, as well, nitrogen and water vapor, or moisture, and carbon dioxide, and other things.

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[116]

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Ethylene oxide is well known and has been well known for a long time to be perfectly soluble in water, as ammonia gas is perfectly soluble in water. And so it can conveniently be taken out by letting the gases bubble through

water; and that will take out the ethylene oxide, and let the other gases go on.

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[121]

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Q. What does that patent say as to the range of

[122]

temperature to be maintained? A. The patent says that you maintain a temperature in the range of 150 about through 400 degrees Centigrade, about.

Q. And is the reaction exothermic or endothermic? A. Of course, the burning of a hydrocarbon is exothermic, as people know who run automobiles, and that means it gives off heat. And the burning of ethylene, some of which occurs, to some extent, as was shown by this second equation, that is, at line 25, that is exceedingly exothermic, and was known to be so, and the value of it is in the literature before 1931. In fact, as long ago as about 1880, I believe.

And also, the reaction before that, at line 18 of the patent, the equation shown there, that is also exothermic, and that was known to be exothermic and to give off heat, too. And since those are the two reactions that occur, why then, the reaction occurring in the reaction tube is certainly exothermic.

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[123]

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In the first place, water is invariably present, because you have two reactions there, and the side reaction forms

water, and there is water in the reaction tube, where the reaction is going on. So there, at that very spot, there is water as that equation at line 25 shows.

In the second place, water can be present in the air, as in the air today, and moisture in the air; in the third place, water could be actually added, if desired.

[124]

Q. The Court spoke about lines 36, et cetera, about heat control. Were means well known of controlling heat in reactions of this kind, that is to say, how to maintain a temperature within the desired range? A. Yes. Yes, indeed, the catalytic reactions are reactions which are exothermic, give off heat, and there-

[125]

fore when you do them on a large scale you are apt to have so much heat come off that you have to control it, and therefore for the early catalytic reactions prior to 1931, there were a number of expedients known. Of course, the obvious expedient, such as shown by that jacket around the tube, is to have a liquid in there to cool it down sufficiently, not too much, keep it up to the desired temperature but don't let it get too high, and control it, in other words. So, that was known. If you have diluents present, they tend to control the temperature, too.

Now, in regard to the diluents, like nitrogen, oxygen, carbon dioxide, or water or hydrogen, which he speaks of here, which you can add or not, as you prefer, as he states here, why, all of those are diluents, and if you dilute the material it is at once apparent that the rate of formation

of heat is lessened thereby, so that you have less heat to control, so that is one way, and so equalizes the heat there.

However, since diluents are chemicals they can not be indiscriminately added, because some chemicals, of-

[126]

course, will break up a chemical process, and therefore the patent does state certain diluents that can be added.

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Q. Now, in line 47 of column 1, it speaks of putting inside the reaction tube a surface catalyst, as one "composed of silver in finely divided form, and which may be disposed within the tube on a supporting material, or in other known ways." What is your understanding of the significance of the words "silver in finely divided form on a supporting material"? A. It mentions silver as a catalyst, and silver as a catalyst is naturally in finely divided form.

As Ellis, in one of his books, states it is so obvious a thing to use a catalyst in a finely divided form that nowadays it seems like an original intuition of the human mind.

At all events, it is customary to have the catalyst finely subdivided, but finely subdivided does not mean that you start with a piece of silver and try to grind it up, which is practically impossible in the

[127]

case of silver, since it is a soft metal, and this has not been ventured by chemists who are skilled in the art. To get finely divided materials they do not grind them up, they would take a compound of the metal, such as a silver nitrate in this case, which would be soluble. Now, to the silver nitrate they add something that would give a pre-

cipitate of silver oxide, the precipitate is already finely subdivided, it is extremely finely subdivided, so that it has been finely subdivided by nature but it still is not silver, so that material would be reduced, the silver oxide would be reduced to silver by means of hydrogen.

The Court: Now, what is the supporting material?

The Witness: The supporting material is a solid which will itself be practically inert and not harmful, and which will hold the finely divided silver on its surface, and the use of the support is to make an economy in the silver, like using silver-plated ware instead of sterling silver, and the foundation can be a piece of brick which has been used successfully, I know, or a piece of porcelain,

[128]

or a piece of Filtros or a piece of Aloxite, and there are a number of materials of that sort that are known, and a number that are in the literature, and in the book of Rideal and Taylor, "Catalysis in Theory and in Practice", published in 1926, on page 123, he mentions the nature of support materials, and he says:

"A variety of substances have been employed as support materials. In addition to those already alluded to, mention may be made of glass, wool, and silica fibres, fibrox, various porous siliceous materials such as fire-clay, lundum, and unglazed porcelain, the various forms of charcoal, anhydrous salts and porous oxides obtained by calcination of suitable materials or by dehydration of gelations, precipitates or gels."

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[129]

By Mr. Watson:

Dr. Stevenson, will you refer to claim 8 of the patent? Do you find support for the language used in that claim from the specification?

[130]

A. Claim 8: "The process of making ethylene oxide by the direct chemical combination of oxygen with ethylene in the proportion of one atom of oxygen to one molecule of ethylene"—well, the object of this patent is the production of ethylene oxide, "by the direct chemical combination of oxygen with ethylene", and through my explanation I have emphasized the directness of the reaction, where the oxygen joins directly to the ethylene, and it is shown very thoroughly here in line 18 of the first column, where you see the oxygen joining directly to the ethylene to make ethylene oxide; "in the proportions of one atom of oxygen to one molecule of ethylene."

And looking again at line 18, the equation we see there, that there are two atoms that join two molecules, using those in the proportion of one atom to one molecule, one atom of oxygen for one molecule of ethylene, to make one molecule of ethylene oxide, and the equation is doubled as it is written, each process being a reaction between ethylene and molecular oxygen.

[131]

It is already understood molecular oxygen is O_2, such as in air, and I don't think there is any question whatever

that that is here many times in the patent and we need not take up any time to show it. "Conducting said mixture through the confined reaction zone", that is shown at line 44, the first column, "through a tube, for example, of silica, which is maintained at an elevated temperature". The elevated temperature is shown at 150 to 400 degrees Centigrade; that is on the 5th line of the first column; "Controlling said temperature to maintain said mixture in said zone at a temperature between about 150 degrees and about 400 degrees Centigrade" and then at line 50, it reads: "The temperature of the reaction zone is maintained between about 150 degrees and about 400 degrees Centigrade". For example, at about 200 degrees Centigrade. "Subjecting said mixture in said zone at said elevated controlled temperature—", well, we have gone through that before and there is no use to repeat. "To intimate contact with an active surface catalyst". The active surface catalyst is mentioned at line 4, second column. Then looking at line 47, "Such a surface

[132]

catalyst", line 5, I believe it is in the presence of a surface catalyst, both in the first column, "of a material having the catalytic charactertistics of silver". Now, a material having the catalytic characteristics of silver you will find in the first column, line 48, 47, "Such a surface catalyst is one composed of silver in finely divided form" is one spoken of there. You will find also the statement in the first column, line 5, "In the presence of a surface catalyst which favors the oxidation of ethylene to ethylene oxide under these conditions", and further down at line 15 you find that occurs without the formation of a significant amount of other compound such as aldehydes, so that that shows what is meant by having catalytic characteristics

of silver. Of course, silver itself has this catalytic characteristic if it is silver in finely divided form, a silver catalyst. The next phrase clarifies that statement and reads as I have just said from the specification which favors the direct oxidation of said ethylene in said mixture by said molecular oxygen to form oxidation products containing ethylene oxide in the presence of water. I would like to say a word about that since the

[133]

simultaneous side reaction shown at line 25 forms water in the reaction tube, inside the tube, this water is always present when that reaction goes on. That reaction goes on simultaneously with the main reaction shown at line 18 of the first column, so that this is in the presence of water. The amount of water is variable. It can be in air or the air can be dry or the air can be very moist indeed or you can add at will extra water or water vapor or water which becomes water vapor. Now, we have read that phrase: "the presence of water and which does not favor the existence in said product of substantial amounts of aldehydes", and I have already read the part in the patent which related to that when I said it was a specific reaction.

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Then the next phrase is "correlating the passage of said mixture through said reaction zone in the presence of said catalyst and the controlled elevated temperature of said mixture and said catalyst to effect said oxidation of said ethylene directly to form

[134]

substantial amounts of ethylene oxide." Now, that phrase shows that there are three things that go on. One is, that

you pass the mixture through a tube which, of course, you see, and you have in there a catalyst and you have a temperature that is an appropriate one in the given range, that you have. Then, I start with the catalyst. To make it specific, I would prepare a silver catalyst. Now, the patent tells me that I can use it between a range of 150 and 400 degrees and use it with this ethylene and oxygen mixture, preferably ethylene and air mixture, to form ethylene oxide. Therefore, I use that silver catalyst on a support or not in the reaction tube such as you have just seen and I heat it up to 150 degrees and I have the mixture go through at a moderate rate and I note whether I get ethylene oxide substantially or not. It is very simple to note that and then I increase the temperature to say 175 degrees and note again and so by going up at intervals and noting I find that at some place within the prescribed range it will act very well indeed. Then I have correlated the temperature and the catalyst and if I want to I can now change the rate of flow, although that rate of flow is

[135]

not critical, I could use that flow, or many times that amount or half of that amount but there are certain economic considerations which determine what the rate of flow shall be should you get a rate of production where the supply will meet the demand and that would be correlation which is the manner of carrying out the acts or steps as we have already said. It is not a separate step by itself but a manner of carrying out these other steps.

Continuing the last phrase in Claim 8, "And thereafter recovering ethylene oxide-containing product in liquid form." We have lines 17 to 20 of the second column "Ethylene oxide can be recovered by known methods, and it may be further reacted to form ethylene glycol or de-

rivatives of ethylene glycol." Also in the second column, lines 1 to 2, they read "The ethylene oxide can be recovered in any suitable way, preferably in liquid form by condensation or solution." I have now read every phrase in claim 8.

[140]

Q. Dr. Stevenson, we had compared the language of Claim 8 with the specification. And I ask you the general question, whether you thus find the language of Claim 8 of the patent in suit justified by the disclosure of the specification? A. Yes, I find it completely so.

Q. I will ask you the same question as to Claim 9. A. Claim 9 I also find completely disclosed. I need not go through Claim 9 in such detail, because Claim 9 is identical with Claim 8, except at three

[141]

places. And so it seems better that I only mention those three places. One is at line 13. "Heat absorbing diluent." And that is shown on page 1, column 1, line 38, or 37—38. In fact, before that, line 36: "This can be facilitated by suitable dilution of the reaction gases such as that accomplished by the use of air as a source of oxygen and some water or carbon dioxide in addition to that formed can be admitted to the mixture in the reaction zone if desired."

Q. What is the next feature of the claim? A. The next part of the claim which is different from Claim 8 is shown at line 21, which is "Surface catalyst material composed essentially of silver." And this is shown in the patent in suit on page 1, second column, line 4—"The surface cata-

lyst is preferably silver as stated." Also, on that same page and column, line 8 through 11, would seem to be the same thing. "Experiments have also indicated a catalyst may be silver

[142]

activated by the addition of small amounts of gold, or copper or iron," when they are minute amounts, it is still essentially silver.

Then the last part of the claim, the last two lines of the claim read differently from Claim 8, reading, "and thereafter separating ethylene oxide from the products of oxidation."

And referring to the patent, second column, first line, we see that ethylene oxide can be recovered in any suitable way, preferably in liquid form by condensation or solution. And in either case that involves separation from the gases that it is with.

Q. You have spoken of the feature in Claim 9, of the heat-absorbing diluent.

You spoke to me this morning about a word which occurs on page 125 of the transcript, the typewritten transcript. A. Yes, I remember speaking to you and saying that I wanted to make a correction. It is not a cor-

[143]

rection of the stenographer, but is a correction due to my own inadvertence, where I included among the heat-absorbing diluents, and apparently I included hydrogen. I spoke of hydrogen first. And then when I discussed the heat-absorbing diluents I did not specifically exclude the hydrogen. And hydrogen is not a heat-absorbing diluent, since under the conditions of this process it would burn to water and give off heat.

* * * * *

Reston Stevenson

[148]

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Q. What is your opinion as to the relation between the process recited in claims 8 and 9 of the patent in suit and the process of the defendant as recited in the statement just handed you?

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A. The defendant's admitted operations as given in this statement conform throughout completely to each and every item in claim 8 and in claim 9. There is a perfect correspondence, and I have, therefore, made this tabulation of claim 8 and claim 9, quoted on one side of the sheet, and on the other side parallel thereto I have quoted extracts from defendant's statement which show the parallelism.

[150]

Q. Doctor Stevenson, would you before concluding give me a summary of what you consider Lefort's contribution? A. In summation I would say that Lefort originated a process in which ethylene oxide is produced directly from molecular ethylene and molecular oxygen by the direct combination of one atom of oxygen with one molecule of ethytene. Lefort discovered that in this production of ethylene oxide he accomplished it by subjecting a mixture containing ethylene and molecular oxygen to his combination of silver surface catalyst and a temperature that is elevated and controlled and is between 150 degrees and 400 degrees Centigrade with water always present in the reaction zone. In Lefort's process the ethylene oxide is produced without substantial formation of aldehydes but with burning some ethylene to water and carbon dioxide.

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[160]

CROSS EXAMINATION BY MR. BARROWS:

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he would use his knowledge as a man who is skilled in catalytic reaction in selecting an appropriate catalytic support or carrier. Naturally, he would require that the catalyst supports do not poison the silver. And naturally he would require that it should not mask the effect of the silver by some catalytic effect of its own. And, of course, he would want the carrier or support to be of a material which would hold the silver, and would hold it spread out. And, apart from that, he has quite a choice of materials that he can take from this page, or elsewhere.

Q. How would he find a support which would be satisfactory? Is there any way except to take it and try it and see?

[161]

A. Yes, for instance, he would see wool fibres. Well, he manifestly would not use wool fibre at a temperature around 300° Centigrade. And you find various other things there. And I know that glass, for instance, is satisfactory. Fireclay is satisfactory. Alundum is satisfactory. Unglazed porcelain. And then you come to charcoal. Charcoal is apt to give a rather dusty product. You would rather not have it. And charcoal, if it is activated carbon particularly, has a catalytic effect of its own. And so you would try naturally something very simple. In fact, the simplest thing that you would try would be silver itself, of course.

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[167]

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The Court: There is no mystery involved in the support used, is there?

The Witness: No, sir, there is not.

The Court: I asked you a question about that, I think yesterday, about the support.

The Witness: Yes. I said that the support is nothing but a solid, mechanical foundation which serves to spread out the catalyst upon it. And that is an economy of the catalyst, especially an economy of a

[168]

silver catalyst. And then I used the analogy of a silver-plated article.

The Court: The reference is on line 48 on the first page, the first column, "and which may be disposed within the tube on a supporting material, or in other known ways."

The Witness: Yes, other known ways, such as pelleting it.

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[177]

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Mr. Barrows: May I ask the direct question of this witness:

Q. Whether he knows any way of designating a silver catalyst other than by the method of preparing it? A. I should say the way it acts, the way it acts, catalytically, and also one may be inferred from the other, but the way

it acts catalytically is certainly a check upon its method of preparation.

Q. And the only way to find that out is to try it? A. Well, I wouldn't say that. If you take the method of preparing silver catalysts by the method of Benton and Elgin which is one that is in the literature before 1931, you will undoubtedly make a silver catalyst by following their method, and it will be active, undoubtedly. I won't guarantee within a degree at what temperature it will be active, no, but it will be active within the range given in the patent.

[178]

Q. Well, do you know any way of telling whether a silver catalyst is effective in carrying out what you consider the process of this Lefort patent except to make it and try it to find out? A. Yes. Yes, you look up the literature on the subject of silver catalysts and you find a number of methods of making them. I have recited one, Benton and Elgin; that will undoubtedly give you a silver catalyst, it will undoubtedly work in this range of 150 to 400 degrees, and it will undoubtedly make ethylene oxide without substantial formation of aldehydes, and you know it in advance.

Q. You say you know that in advance? A. Know that it will?

Mr. Barrows: Yes.

A. Yes, yes.

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[943]

Thereupon—

RESTON STEVENSON, produced on behalf of the Plaintiff in rebuttal, having been first duly sworn according to law, was examined and testified as follows:

DIRECT EXAMINATION BY MR. WATSON:

Q. You have heard the testimony in the case since you were on the stand and gave your testimony in prima facie? A. Yes.

Q. The defendant's witnesses have stated that in their opinion the processes disclosed by the original and Reissue Lefort patents are fundamentally different. Have you read the original patent? A. Yes.

Q. And studied it? A. Yes.

Q. What have you to say in expressing your opinion on the question of fundamental identity or fundamental disparity between the processes disclosed in the original and

[944]

Reissue Lefort patents? A. I found them fundamentally the same.

Q. What are your reasons for that opinion? In answering I may suggest, Doctor Stevenson, that the Court has indicated we want to come down to brass tacks as rapidly as possible, and, therefore, make your answer as comprehensive as you wish but also as terse as possible? A. I think I should first begin in regard to water since his Honor has expressed interest in that particularly, and in the Reissue patent I find that the presence of water in the reaction zone is mandatory and the situation in the reaction zone is a paramount consideration because it is in the re-

action zone that the ethylene oxide is prepared and it is there where any effect of water would be noticed even as any effect of silver in the reaction zone is noticed and besides the two experts of the defendant agreed that consideration of the water should be for the water in the reaction zone.

I find that the Reissue patent makes the presence of water in the reaction zone mandatory in claims 8 and 9. In claim 8 I find at line 34 the phrase "In the presence of water", and that same phrase "in the presence of water" I

[945]

find at line 25 in Claim 9, and obviously "in the presence of water", would mean that water is there and looking at that phrase with more care you see that it is a phrase which defines or describes the active surface catalyst and, that active surface catalyst acts in the presence of water and it is acting while this water is there; also turning to the specification of the Reissue, I find in the first place the equation of complete oxidation at Line 25 and I should like to have the easel brought up with that equation on it, though I shall go on while that is being done.

The equation to complete oxidation shown at line 25 of the Reissue patent shows the formation of carbon dioxide and water and that water that is formed is formed in the reaction zone which is the very place it is needed, if at all, and the equation is the best way to express the fact to a chemist because he understands it very well indeed from an equation and it expresses it quantitatively to him in that equation and in the equation above given at line 18. Water is not a reactant in either equation, although it is a product of the second.

By the Court:

[946]

Q. May I ask you right there, if that is true, what do you understand to be the value of claims 8 and 9? Why do you need those? A. You need claims 8 and 9 because you wanted to have, for instance, a substance essentially silver and not a substance which is either silver or something else or is a metal selected from a group and then you did not want the restriction upon claim 8 and 9 that hydrogen had to be present, which is in some of these claims also.

Q. What did you understand to be Mr. Boynton's stated reason for putting Claims 8 and 9 in? A. Well. I did not listen to him to tell you the truth because I was thinking of what I was going to say. He spoke just then, I really did not listen to him, sorry, but I didn't, but I am willing to give you my reason as I understand it, if you care to hear it.

Q. Very well. A. In Claim 1 we have that the catalyst is silver and must be activated by small quantities of these other materials. That is quite a restriction upon it and you do not want to have that restriction, so that ends that claim.

[947]

Claim 2 is not for silver but is a catalyst which is a mixture, a mixture of silver, gold, copper and iron, so that that is a mixed catalyst and we would rather not have that, at least I do not want to be restricted to that. We do not mind one claim in the patent doing that but we do not want to be restricted.

By Mr. Watson:

Q. Doctor Stevenson, what is the significance of the first equation in the Reissue? A. The first equation of the

Reissue shows that ethylene and oxygen under a catalytic influence will make ethylene oxide and that was certainly the basic pioneer discovery of Lefort and he thought that he was entitled to that, and I presume that Mr. Boynton thought so. I think so anyhow, I will testify, and not to be restricted as some of these claims do.

Q. Referring to that first equation, is that the equation the single equation in the Reissue which shows the production of ethylene oxide? A. Oh, yes, that equation is the equation for the production of ethylene oxide. That is the equation I call

[948]

the Lefort reaction.

Q. What are the reactants as shown by that equation? A. Ethylene and oxygen only and not water and not carbon dioxide.

Q. Turning to the original patent, the original Lefort patent, do you find that same equation in the original? A. Yes, that same equation is at line—well, between lines 10 and 15 on the first page.

Q. Does the equation carry the same significance in the original that it carries in the Reissue? A. It does indeed. It is identically the same equation and means the same thing to the chemist.

Q. What in that case are the reactants yielding ethylene oxide? A. The reactants are ethylene and molecular oxygen.

Q. Refer please to the original patent and tell me whether in your opinion that indicates a permissive use of added amounts of water in the entering gases? A. Why, a chemist would infer from that that water is unnecessary as a reactant for that equation and, in fact,

[949]

if he looked at the other equation that accompanies this as a side reaction, he finds that water is unnecessary as a reactant for that equation also.

Q. Do you find anything else in the original which indicates the permissive nature of the added water in the entering mixture as distinguished from the water in the reaction zone. A. Yes, in a number of places. I find at line 10 on the first page and the second column "Water can be admitted in the reaction vessel", after which I find a comma and therefore I pause and resuming "either in the liquid state, or as steam", and furthermore you will find here—just a moment—"The oxygen can be the oxygen of air." There "can" is used in that sense. I find also in the same sense doubtless "For increasing the yield in ethylene oxide, I am reading from line 19, first page, second column "For increasing the yield in ethylene oxide, the process can also be carried out under a pressure lower than atmospheric pressure", which has no applicability, but I find above that at line 14, "The efficiency of the reaction is increased by diminishing the CO_2 which is formed, by introduction, in this reaction, of a suitable quantity of water." If the efficiency

[950]

is increased, there must be some efficiency before it was increased. Evidently he thought you could at times add water and get beneficial effects.

I find in line 45 of that second column of the first page "If certain quantity of CO_2 is previously introduced", which is permissive or optional, that is for CO_2, in fact, I think no one has questioned that but the same thing is said above with regard to water on line 36, it says "It re-

sults that, if water is introduced in suitable quantity", and so forth. I find on page 2, the second column, lines 1 through 5, "The experiments effected by the applicant have shown that, in presence of the catalyzers indicated, water, in the form of steam or not, considerably promotes the reaction ensuring the production of ethylene oxide". There is no comma after "reaction" and so you read that straight along, "promotes the reaction ensuring the production of ethylene oxide". That is exceedingly clear in the French patent from which it is taken which says: Fr. Pat. 739,562 p. 2, l. 63; "l'eau, sous forme de vapeur ou non, favorise considérable—ment la réaction de production d'oxyde d'éthylène." And so, I admit that I cannot invoke the French because this is not French here, but it took that as a source undoubtedly.

[953]

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In the first place, the Reissue Patent is rewritten, and rewritten in what was considered, and which I consider a better and clearer form. The original patent, however—the Reissue is in the better form, I hope I said—the original patent, however, represented what your Honor called the evolution in the invention that went through the 729952 and the 739562 French patents, with their four additions, and their one addition respect-

[954]

ively, making, therefore, seven of those little French patents. And in those the subject was developed, and he did not develop this second reaction of complete or destructive oxidation until the fourth addition of the 729 Patent, and until the first addition of the 739 Patent. And so I suppose

that in writing them up he wrote them up somewhat in following that order. That is what I think was done. He very clearly says, however, about that, that it is a reaction of oxidation independent from the other reaction; that these two reactions, therefore, are independent of each other; as I call them, side reactions.

. . . . . .

[958]

. . . . . .

The Court: I would like you to give me an answer to that last question. Do you consider that this matter of water is really material, except in connection with the object that the Frenchman speaks about?

The Witness: Well, the Frenchman does not speak about merely omitting the water in the entering gases in that patent. I think you have been misled in that theory, because when it was said that that is the construction that must be put upon that as inventive novelty, the omission of water in the entering gases, why, no reference was made to that very statement, made long before, years before, in resumé 5 of the French patent 729952, and which reads, "By avoiding the addition of water to the reaction one can obtain solely ethylene oxide." So that that could not have been the inventive novelty, because that had already been published, published in France, and years before.

The Court: Well, you just mean he does not know what he is talking about?

[959]

The Witness: No. Well, he may not be right, but he did give a novelty there. He said that he was going

to obtain ethylene oxide without any water present, in the absence of water. In other words, absence of water in the reaction zone, of course, because the British patent that was referred to by Dr. Taylor, who considered those two patents, the French and the British specification together—and they are the same patents, of course—and it reads here—I will quote the very paragraph that he quoted from, page 1, lines 65 to 70, "Thus, according to the present invention, ethylene oxide is produced by the catalytic oxidation of ethylene in the presence of an inert gas and in the absence of water." And I think that is the asserted novelty, because that would have been a novelty at that time. And I have to put upon this patent some construction that would give it life, if true. And that is what I say is the novelty. And, of course, if he did that, that would result in a very great increase in efficiency, none of the ethylene being wasted by burning it up and which would form water, you see.

[960]

Q. (By Mr. Watson) Dr. Stevenson, if any one did operate the process completely in the absence of water in the reaction zone, as indicated in that last British and French patent, do you think that he would be conducting practices covered by Claims 8 and 9 of the reissue patent in suit? A. No, certainly not, certainly not, because those patents, those claims say, "In the presence of water," and this says, as inventive novelty, the very opposite, "in the absence of water," which makes it hard to see how you could invoke a patent requiring the absence of water to put in two claims that read in the presence of water.

The Court: Now, I understand you, but that, I think, puts me squarely up against my first dilemma. You see, the claims require the presence of water.

The Witness: In the reaction zone.

The Court: But the specifications in the reissue patent apparently do not require it in the first reaction.

[962]

The Witness: My explanation of that is that I would not consider it significant because in the specification it is stated that water must be present. In the first place, the fact that it is an accompanying reaction which produces water and goes on at the same time as an original reaction, and I know that it does go on, and I do know that as water is formed more and more ethylene oxide is formed, too; so then, inevitably, water is present, and to the chemist it would mean that, because the equations are to the chemist the most eloquent expression of anything occurring.

I would like to read to you also on the second column of the first page, lines 12 through 15:

> "In any case, the ethylene and oxygen are thus reacted simultaneously at the temperatures set forth in the presence of a surface catalyst and of water."

That certainly reads the presence of water there, so that the specification contains it, and it seems to me to require it at one place rather than another is to criticise it for its literary style but not for the substance of the disclosure.

[965]

By Mr. Watson:

Q. Dr. Stevenson, referring to the original patent and the second equation in column 2, line 40, what produces the Figure 2 H_2O in that equation? In other words, does it come from the reaction of water which has been suggested might be added by him then, or does it come from the ethylene? A. The water in that equation is not any water that was already present but it is water that is formed by a reaction and it comes from the hydrogen atoms of

[966]

ethylene combining with the oxygen atoms of the molecular oxygen.

Q. Well, my point is, considering that second equation, is it true that the preceding mention in the specification of the permissive addition of water to the entering gases refers not to effecting a reaction expressed in the equation, but refers to suppressing the reaction expressed in the equation? A. That is precisely true. At least half of that second column on the first page of the original U. S. is given to the theory that the applicant had in regard to supressing that reaction of destructive oxidation by means of the addition of water, if he cared to do it.

Q. What is your opinion, then, as to whether the side reaction indicated in that second equation in the original, is one which accompanies simultaneously the ethylene oxide formation expressed in that first equation? A. Yes. I know that it does, and I understand that it is so disclosed in this original U. S. patent.

Q. Then what is your opinion on the matter preceding the second equation in the original, viewed from

[967]

the inquiry of whether that matter indicates that the additional water causes this reaction or the contrary? A. No, I know that the addition of water does not cause that reaction. I know that the addition of water is unnecessary to make that reaction shown in the original U. S. at line 41 of the first page, the right hand column, and any addition of water, if made, is made according to the theory of the patentee, to suppress that reaction.

Q. Considering the substance of the disclosure of the original patent, what is your opinion as to its instruction to a chemist that in the production of the ethylene oxide by the equation in lines 10 to 15 of the first column, there is an accompanying side reaction according to the equation expressed in line 41 of the second column? A. The two equations given in the reissue are identical with the two equations given in the original U. S. In both patents they are characterized in such language that the chemist would see that they occur simultaneously and are side reactions. No matter where their place in the patent may be, their place in the

[968]

reaction tube is simultaneous.

The Court: Well, I don't think you need pursue this any further. I understand, in substance, you agree that it should not occur to any one skilled in the art that the addition of water is absolutely required, but that the reaction does take place in the presence of water, whether you put it in there or not?

The Witness: Yes, quite so, water from whatever source, water occurring in the air or deliberately put in or formed in the reaction zone on the job.

By Mr. Watson:

Q. Summarize your opinion, then, as to the correspondence of the original and reissue patents on this question of the presence of water in the reaction zone and the permissive presence of added water in the entering gas mixture. A. I will do that by making a statement first in regard to the reissue, and then making a statement in regard to the original U. S.——.

The Court: Well, you have already done that, haven't you?

[969]

The Witness: Yes, sir, I have, in a sense: I have said for the reissue that the presence of water in the reaction zone is mandatory under claims 8 and 9, and in the specification, and I have read the part of the specification that makes it mandatory. I would like to show that in the reissue patent it is not mandatory for the addition of water to the entering gases, but optional.

• • • • •

By Mr. Watson:

Q. Have you prepared a tabulation in columns of the disclosure of the original, the reissue, the first French and the second French addition with respect to

[970]

these items of water and things that are in the claim? I just want to have that identified and put it in as an exhibit, because I think it will be helpful. A. Yes, yes, I have prepared this and it refers to the three items given

in paragraphs here, which I gave as the summary of Lefort's contribution; and it has, among other things, water as always present in the reaction zone. That is one of the statements in there.

The Court: Let me have a copy of that.

(Copy of paper referred to handed up to the Court by Mr. Watson.)

Mr. Watson: I think your Honor will find that very helpful. I think I should say, however, that the quotations from the two French patents are given in French, we did not translate them, while there are translations in the case, but they are very simple, indeed, and, I think, it might possibly be more informatory to read them as they are.

[971]

Everything on these sheets are quotations. There is nothing added except the large black print in the lefthand column which is a generalization of the Lefort process. I offer the tabulation compiled by the witness and just referred to by him in evidence as Plaintiff's Exhibit 20.

(Tabulation of Doctor Stevenson marked Plaintiff's Exhibit 20.)

• • • • •

By Mr. Watson:

Q. Doctor Stevenson, what is your opinion as to the adequacy of disclosure of the original and Reissue Lefort patent with respect to teaching one skilled in the art to produce a silver catalyst effective for carrying on the process?

• • • • •

[972]

A. * * * I will have to say that I consider the disclosure of both patents is adequate for one skilled in the art, as, in fact, established by the experiments of Doctor Lamb. He got very good efficiency indeed with these experiments. They were efficiencies that correspond and, in fact, were somewhat greater than sometimes is obtained in commercial efficiencies.

[974]

Q. In your opinion, do claims 8 and 9 of the Reissue cover any process not disclosed by the original and indicated by the original to be part of Lefort's asserted invention? A. No.

Q. In your opinion is the recitation in claim 8 and claim 9 respectively of an active surface catalyst of a material having the catalytic characteristics of silver, claim 8, and an active surface catalyst material composed essentially of silver, in your opinion, are either of those definitions of a catalyst functional? A. No.

Mr. Edmonds: It is only part of a definition.

The Court: I did not hear you.

Mr. Edmonds: Counsel asked only about a part of a definition.

The Court: Take it all into account.

The Witness: I will answer it my way and see if it

[975]

answers the question. If I take claim 9 I find that in regard to the catalyst it says "surface catalyst ma-

terial composed essentially of silver." Now, up to that point and not going any further momentarily, that is certainly definite because we know what that means and that is not, I presume, functional at that moment. Now, there is a phrase that follows that, which is a phrase descriptive of the silver catalyst but that phrase that describes the silver catalyst does not in any way make it any broader than it was before and certainly cannot nullify the definiteness that it had before. It has not in any way changed that definiteness, as I understand it.

Now, coming from claim 9 and coming over to claim 8, that same descriptive phrase occurs after the surface catalyst but here the active surface catalyst is of a material which is silver and the materials that are the equivalents for silver in this process as disclosed in the patent from line 4 to line 11 on the first page, second column.

Mr. Watson: You need not quote them.

The Court: I don't think you need to pursue this further because the proof of the pudding is in the eating and

[976]

we have two examples at least that the process is working.

* * * * *

CROSS-EXAMINATION BY MR. BARROWS:

* * * * *

Q. You don't know of any processes where water is added to check the reaction, catalytic reaction? A. Of course, if you added enough water you would check any reaction of oxidation, whether it is liquid water or steam. In fact, you use steam for putting out fires in

[977]

the hold of a vessel but that would be answering it in a general way. I think it should be more specific.

Q. Well, let's be specific. You have mentioned the Benton and Elgin catalyst as a catalyst which you thought might be a proper catalyst to use in the process of this patent. You recall that? A. I mentioned it as a catalyst that I know is good.

[981]

Q. Well, is it your position that this third French patent No. 771650 is one which is supposed to take place in the absence of any added water, and also in the absence of any formed water? A. Yes; yes, indeed. It says the absence of water. I presume it means all water.

[983]

Then, I find that in the third French patent which says very distinctly, and in the British counterpart, that it is to be carried on in the absence of water, and so I take that as what he claims. I do not guarantee that he could accomplish it. But I take it as what he claims. And he also uses the word "suppress" here, suppress or limit it. I suppose that suppression meant complete limitation.

Q. Well, now, Dr. Stevenson, if you assume that the third French patent and the third British patent and the original United States patent are talking about this undesirable

complete reaction to form unwanted products, carbon dioxide and water, and if you assume that that is something to be checked and limited, and only to the extent that you can not prevent obtaining it do you get it,

[984]

and if you think of water which is added afterwards, do you think it is doing violence to English language to construe them as saying that the dry gases he is talking about are the dry gases that go in, and that this unwanted reaction is to be prevented as much as possible— A. Well, I have already explained that he could not possibly have advanced that as his inventive novelty, since it had been published a year or more before. I think it is unnecessary to read that again. I refer to it, though, the resume 5 in the French patent 729952.

Q. But you do agree that the reaction of this third French patent, which results in the formation of carbon dioxide and water is an undesirable reaction, to be checked so far as possible. A. It would be a desirable thing to check; and if you could check it completely, and also have the main reaction going on, of course, it would be a very good invention; I should like to make it myself.

[987]

Q. Well, now, do you find anything in this reissue patent to indicate that this formation of carbon dioxide and water is an undesirable reaction, which is to be checked, and which is to be prevented so far as possible? A. None except the fact that it is obvious, and no man wants to pay

for ethylene and then burn it up to the worthless products we have been talking about.

[988]

Q. Well, is it your position, Dr. Stevenson, that the process of the original Lefort patent, or the process of the reissue patent, is one in which the production of ethylene is by oxidation of ethylene in the presence of a catalyst, with or without inclusion of water in the reaction? A. Oh, no; no, indeed; no, indeed. I made it very clear that the reaction goes on between ethylene and molecular oxygen in the presence of the silver catalyst, and at the temperature range indicated, in the presence

[989]

of water in both patents, in the presence of water in the reaction zone, where the reaction is going on.

Q. Well, then, when Mr. Lefort in his reissue oath referred to something that he wanted to accomplish by his reissue, that is, the production of ethylene oxide by oxidation of ethylene in the presence of a catalyst, with or without the inclusion of water in the reaction, you say that is something that he did not know what he was talking about?

A. I do see something of the sort said by Lefort in the oath, where he wanted—he thought that he had made a disclosure of such pioneer nature that it ought to include the reaction between the ethylene and molecular oxygen, even if some one later arrived at suppressing that reaction of complete oxidation which results in the formation

of water. He had not arrived at suppressing that himself. But if

[990]

any one in the future did, he made that statement there, because of the pioneer nature of his invention. And I understand a good deal of latitude is given to pioneer inventions. He did say, however, later—he made that later in the subsequent oath—he did not claim so wide a scope. He saw that his file history had been such that he could not claim any such thing; and he also realized, perhaps, that the fact that he had not yet really achieved it would not permit him to reach out that far, because later he did not, he did not in the later patent state that.

[992]

Q. With a large amount of steam present blanketing the oxygen molecules or atoms on the surface of the silver catalyst, you would restrain the complete oxidation of ethylene to carbon dioxide and water? A. Well, I don't know what you mean by a large amount. If you would put a very large amount of steam in, neither one of these reactions would occur. Of course, I have said you put out fires in the holds of ships by putting in steam under pressure, so it would certainly stop this.

[993]

Q. Now, you said in your direct examination, comparing the original and the reissue patents, that the equation,

that is, ethylene plus oxygen to give ethylene oxide is the eloquent thing to a chemist. Now, in catalytic chemistry where you have a surface with ethylene and oxygen and steam molecules on the surface would you say that it is also of significance if you have a large enough number of steam molecules on the surface to retard or restrain complete oxidation of ethylene to the undesirable or unwanted reaction product? A. No, I think not, in a practical way, for this reason: I know you can remove nearly all the water so that you have almost nearly, say, two one-thousandths of a per cent of water, in the entering gases, and in that case you will get a production of ethylene oxide from the catalytic reaction of ethylene and oxygen over silver in the range specified here and get good efficiency. I know that if you increase that by adding a little steam, which is the popular term for water vapor, water vapor

[994]

being the generic term, if you add a little water vapor then you will still get the production, you can still add the water vapor. I have had experiments performed up to 3½ per cent water vapor, and in that range I got about the same efficiency. There was practically very little difference among them. Why should there be? It is the difference between a moist—not between a dry reaction and a wet reaction—it is the difference between an inevitably moist reaction and one which is a little moister. It is true that I did not keep the temperature constant, no I raised the temperature until in each case I was getting the best results, because, naturally, I compared each one acting well with the other.

[1001]

The Court: Dr. Stevenson, I have one question: As far as the French patent, that is, the late patent, which it has been suggested is the reason for the introduction of the reissue claim——

A. Yes, sir.

[1002]

Q. Am I correct in this understanding, that what you claim for the French patent is that it is an attempt to make ethylene oxide completely without water? A. Indeed, that is what I think is the asserted novelty.

Q. And therefore, if I understand you correctly, you say that whether we assumed that it was considered and known by those who made the Reissue application, that as you interpret the Reissue claims, they are entirely distinct from the French patent in that you find that water is still mandatory in the Reissue claims? A. Yes, that is true, sir.

Q. In the new claims of the Reissue patent? A. Yes.

Q. And that regardless of whether the French inventor has a successful operating process, regardless of whether his patent is valid or invalid, that you contend that the two things in claim under that third French patent and the claims under the new claims of the Reissue patent are entirely distinct? A. That is exactly my attitude, exactly.

[1006]

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Mr. Watson: The Plaintiff offers in evidence a copy of the Taylor patent heretofore marked for identification. * * * Exhibit 10.

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[1007]

(Exhibit previously marked Plaintiff's Exhibit 10 for Identification now marked Plaintiff's Exhibit 10.)

Mr. Watson: I offer Plaintiff's Exhibit 21, a folder of correspondence and cables which has been supplied us by defendant's counsel and therefore the authenticity of which I presume will be accepted.

[741]

Testimony of Emory P. Boynton.

Thereupon——

EMORY P. BOYNTON, a witness of lawful age, produced on behalf of the Defendant, having been first duly sworn according to law, was examined and testified as follows:

DIRECT EXAMINATION BY MR. EDMONDS:

[743]

Q. Now, you are familiar with this cablegram, which was marked as Exhibit No. 5, aren't you (handing paper to witness)? A. Yes, sir.

Q. Was anything received from Mr. Chalas or his associates, sent by him or them, between March 6, 1936,

[744]

and the date of this cablegram, March 12th? A. No. As I recall the facts, and I think I know them, the cablegram

which we received on March 12th was the first communication which we received from Mr. Chalas.

Q. And then this Exhibit No. 3 came in next? A. Yes.

Q. And what was the next thing, this Exhibit of March 28th, this cable of March 28th? A. No, there were some other exchanges of cables between our company and Mr. Chalas, dealing with the matter of how soon he could get a definite order, arrange with the French company for——

* * * * *

Q. The actual consummation of the purchase of these patents was a little later, wasn't it? Or, rather, this

[745]

one patent we are talking about, and possibly something else. That came a little later, didn't it, in May or June? A. No, you have a cablegram there saying that the deal has been closed, or words to that effect.

Q. Yes. A. Dated March 28th.

Q. I mean the actual signing up? A. Yes. And we requested a lawyer from Norway to come to Paris, and he did, and drew up an agreement, which was then merely a protocol agreement.

Q. Do you remember the date when the deal was consummated? A. About the middle of April, 1936.

Q. And was there more correspondence prior to that date, or cables, than what you have already referred to? A. Between which dates?

Q. Up to that date of closing, April 16th, or whatever it was? A. Yes, but they were mostly with this lawyer in Norway, about how soon he could get down to Paris to draw

[746]

the agreement.

* * * * *

CROSS-EXAMINATION BY MR. WATSON:

Q. Did any of these other cables or correspondence that Mr. Edmonds referred to deal with the chemical subject matter, or did they deal with financial terms? A. Only with terms.

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[747]

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Mr. Watson: There is one question I want to ask. The Court will recall that the occasion for the witness was to allow Mr. Edmonds to find out whether there was a document in existence. Now, that question Mr. Edmonds did not ask the witness at all.

Q. (By Mr. Watson) Did you make a search for such a document? A. I presume that you refer now to the hypothetical

[748]

or possible United States application corresponding to British specification 431966 and the French patent 771-something?

Q. Yes, sir. A. Yes, I searched the assignment records in the United States Patent Office, under the French company, Francon and Lefort. I also asked the French company if they had any more applications than the one application which they assigned to us with the original Lefort patent. I also asked the United States attorneys for the French company whether there was another application than that one. I did everything that I knew how to do to find its existence. And I found none.

* * * * *

[796]

Testimony of George H. Law.

Thereupon——

GEORGE H. LAW, a witness of lawful age, produced on behalf of the Plaintiff in rebuttal, having been first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION BY MR. JOHNSON:

* * * * *

[812]

* * * * *

Q. Did you recently conduct some informatory tests at the South Charleston Laboratory in the presence of Doctor Frazer and the representatives of the defendant? A. Yes, we did.

Q. Have you the notebook for that? Are these the ones? A. Yes.

[813]

Mr. Johnson: We offer the notebooks as physical exhibits.

(Second and third notebooks of Doctor Law marked Plaintiff's Exhibits 15-A and 15-B.)

Q. Can you give us a blueprint of the apparatus which was used in that experiment? A. Yes, I can.

Q. Is that it? A. That is it.

Mr. Johnson: We offer the blueprint identified by the witness as Plaintiff's Exhibit 16.)

(Blueprint of apparatus identified by witness Law marked Plaintiff's Exhibit 16.)

* * * * *

[840]

Thereupon—

GEORGE H. LAW, recalled by the Plaintiff, testified further as follows:

REDIRECT EXAMINATION BY MR. JOHNSON:

Q. Doctor Law, will you explain somewhat more in detail what you did in South Charleston in the presence of Doctor Frazer and the representatives of the defendant? A. We prepared a silver catalyst by precipitating silver oxide from a solution of silver nitrate. We washed that carefully to remove any impurities, made a slurry of it in water and evaporated it to dryness in the presence of a Filtros carrier or Filtros support, which is an artificial form of silica. That was placed in a glass tube practically identical to that.

Mr. Johnson: Indicating Exhibit 3.

The Witness: And so reduced with hydrogen for four hours over a temperature range of 100 to 250 degrees. We then started passing the mixture of air and ethylene over the catalyst. We found originally when we started with about a five per cent. ethylene and 95% air at a feed rate of about

[841]

50 litres per hour, our first attempt at operating this, we had difficulty in controlling the temperature due to the rather crude apparatus we had. We wanted a glass apparatus in which everything would be perfectly obvious and clear. This was not considered as a test. It was more

of a demonstration. We allowed the temperature to drop somewhat and then started feeding up more ethylene to the rate of about two or three per cent. and got a positive test for ethylene oxide and a negative one on the inlet gas and I am not able to recall exactly the efficiency on this.

[842]

As I recall, we got about a 10 per cent yield, and something around a 30 per cent efficiency. We did not attempt to operate that for any extensive period of time. It was, as I say, merely a demonstration of how we would prepare a catalyst. At the time Dr. Frazer arrived we had an oil-jacketed tube in operation, which contained a catalyst which had been made in exactly the same way, the same support. That had been operating, as I recall, for about 48 hours when he arrived. We attempted to isolate some ethylene oxide from effluent gas that that gave. But the apparatus we used was admittedly not enough to get a quantitative recovery of ethylene oxide. However, we did recover some, and demonstrated that it was present. I think that—yes, in the entering gas we had a water concentration of 1½ per cent. The feed rate varied somewhat from 50 litres an hour, as I recall, to somewhat lower. The ethylene concentrations also varied. I believe we varied them from about 5 per cent to 15 or 20 per cent. We continued operating that tube for an additional 48 hours, and raised our yields to about 32 per cent, and efficiencies of the order of 60 per cent.

[843]

Q. Can you tell me whether or not it has been your experience with catalysts, properly prepared, they nevertheless increase in yield and efficiency of ethylene oxide production as they are run? A. Yes, that is usually the case.

Q. In the reaction zone in those experiments that you conducted, take, for example, the one in the glass tube, where no additional water was added to the air-ethylene mixture being fed in, can you tell us what the condition was as to the water in the reaction zone?

* * * * *

A. As soon as the reacting gases hit the catalyst, ethylene oxide, and water, and carbon dioxide would be produced simultaneously, as nearly as we can determine, and the production of both ethylene oxide, and water, and carbon dioxide would continue throughout the length of the catalyst bed.

[844]

By Mr. Johnson:

Q. And so far as the chemistry of the process is concerned, what is the effect of changing the inlet water content, for example, from two-thousandths of a per cent to two thousand times that amount? A. There would be no difference in the chemistry of the process.

* * * * *

Cross-examination by Mr. Barrows:

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[846]

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The Court: As I understand it, Mr. Law, you are in substance saying that you agree with Professor Lamb, that you do not think the use of water makes any difference one way or the other.

The Witness: Chemically, no, it is the same reaction.

The Court: Do your experiments, culminating in this particular experiment, lead you to the same conclusion that I understand Professor Lamb testified to, that the use of water is not a material variation in the process?

The Witness: That is correct.

The Court: That you can or can not use it at will?

The Witness: That is right.

The Court: And that you will get the same, substantially the same result?

The Witness: That is correct.

* * * * *

[851]

* * * * *

Q. Well, you do know that this catalyst without added water to the catalyst will not operate at that temperature, don't you? A. No. I have operated catalysts of this identical composition on another support, over the entire range from 150 to 400 degrees, in an oil jacketed tube.

[861]

By Mr. Barrows:

Q. One other question, Doctor Law. Before you undertook this work early in 1936, you had had a good deal of experience on catalytic oxidation reactions, I take it? A. Yes.

Q. Including the catalytic oxidation of ethylene? A. I don't know whether I had done any work on that or not.

* * * * *

REDIRECT EXAMINATION BY MR. JOHNSON:

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[862]

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Q. Your attention was called to U. S. Patent 2142948. May I ask whether, if you know, your company is using that process of activating silver surface catalysts commercially? A. No, they are not.

Q. Were there other well known ways of activating silver surface catalysts than that? A. Yes, there were.

Q. Prior to 1931?

[863]

A. Yes.

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[890]

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Testimony of Granville A. Perkins.

Thereupon——

GRANVILLE A. PERKINS, a witness of lawful age, produced on behalf of the Plaintiff in rebuttal, having been first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION BY MR. WATSON:

Q. What is your occupation, Dr. Perkins? A. I am employed in the research and development department of the Carbide and Carbon Chemicals Corporation, as a chemist.

Q. How long have you occupied that position?

[891]

A. I have occupied that position since 1929; eleven years.

• • • • •

Q. Can you give a brief statement of your qualifications as a chemist? A. I graduated from Cornell in 1913 with the degree of A. B., specializing in chemistry, and have the degree of Ph. D. from the University of Pittsburgh, in 1917.

I have been in various positions since then in chemistry, and spent eight years in the Philippine Islands, working for the Philippine Government in the research and manufacture of drugs for the treatment of leprosy. And then in 1929 I was employed by the research and development department of the Carbide and Carbon Chemicals Corporation, and since then have been engaged in chemical work.

Q. You were present during the demonstrations made in South Charleston before Dr. Frazer? A. Yes, sir.

Q. You have been present during the trial?

[892]

A. Yes, sir.

Q. It has been suggested by a witness for the defendant, who was also present at that demonstration, that there might have been a feature that was unusual or abnormal in the selection of Filtros as the carrier on which to deposit the silver catalyst. What have you to say on that? A. Well, I see nothing unusual in Filtros as a carrier. I have known it used commercially as a carrier since 1929 for catalytic operations commercially. It is spoken of in a patent which issued in 1914, as a carrier; and, furthermore, it is silica in an inert form. Now, we have heard considerable about silica gel here as being an inert carrier. The fact is that silica gel is the most active form of silica that I know of; and it has been used as a catalyst itself in a great many operations. And it is also well known that any substance when finely divided, or in a form having a greatly extended surface, such as silica gel, is very active catalytically as compared with the fused substances. Now,

Filtros is silica gel in a fused form, or, at least a form which has been heated

[893]

quite highly, and is one of the most inactive forms of silica that I know of.

* * * * * *

Q. What have you to say on the possible criticism of the demonstration, that you were unwarranted, or that it was something unusual to use as much as 30 per cent of deposited silver on the support? A. Well, commercially catalysts are used on carriers sometimes in small amounts, sometimes in medium amounts, and very often the catalyst is put in the reaction zone without any supports. That is, 100 per cent catalyst, comprising the contact mass, as it is called. And we have

[894]

tried silver in percentages of anywhere from around 2 to 100 per cent of the catalyst mass; and it works in all of those percentages. I believe that Mr. Carter's records show the same, as nearly as I can recall; that is, that he tried several percentages, starting in with about 2, 50 and 100 per cent, and that usually he got ethylene oxide with those percentages, provided he did not poison the silver with something that might be there. So I think there is nothing unusual commercially or otherwise in the choice of thirty some per cent of silver. We had to take some per cent.

Q. You heard the testimony of the defendant's witness, Mr. De Jong? A. Yes.

Q. Who recited what he did in Emoryville, in California? A. Yes.

Q. What have you to say to his ability and the propriety of his laboratory technique or procedure on the question of its constituting a proper inquiry into the operativeness of the Lefort disclosure?

[895]

A. Well, Mr. De Jong at the time of the experiments certainly was an inexperienced laboratory assistant. He had only made a few tests, I believe about two hours on each test; and I would say that these series of tests were in the hands of an unskilled man, one entirely inadequate to test any catalytic process. All catalytic processes, or, at least, most of them, are rather delicate as far as manipulation is concerned, and one must be careful not to allow traces of poisons to influence the catalyst.

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[896]

Q. Had you finished your answer? A. Well, I think we can say also that from the instructions that Dr. Groll gave Mr. De Jong, that the proposition had not been very well considered by Dr. Groll, assuming that he was a skilled man, because no really good silver surface finely divided catalyst was tried in that whole series of experiments. Silver turnings are all right for high temperature operations, particularly if they are worked long enough so that they become activated on the surface, if they acquire the characteristics which I think Mr. Carter described of his rivets. But to take fresh silver turnings, as Mr. De Jong did under Dr. Groll's instructions, and to try them for two hours, and then put a little mercury on, and also work a short time to try to get the mercury off, mercury being a powerful catalyst poison, I do not think it showed very good technique.

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[897]

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CROSS-EXAMINATION BY MR. BARROWS:

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Q. Do you think the treatment of silver with mercury and distilling off the mercury is not a proper method of making a silver surface catalyst? A. I think it is a proper method if it is worked long enough so that you can be sure that all the mercury is off the

[898]

silver, but if the mercury is not all off the silver, it would tend to poison the surface.

Q. Are you saying that in the test that was carried out the mercury was not all off the surface or don't you know? A. The data we have, I don't think shows convincingly that it was or was not, but I am inclined to think that it was not since it did not give the desired results.

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[922]

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Mr. Watson: Before we adjourn, I have asked Mr. Edmonds to consent to or admit that that photo copy of the form of assignment used by the defendant is the usual standard form of such assignment.

Mr. Edmonds: That is the common form used by the Air Reduction Company, Incorporated;

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[924]

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"AND I HEREBY further covenant and agree that I will communicate to the said Company, its successors, legal representatives and assigns, any facts known to me respecting said improvements, and testify in any legal proceeding, sign all lawful papers, execute all divisional,

[925]

continuing and reissue applications, make all rightful oaths, and generally do everything possible to aid the said Company, its successors, legal representatives and assigns, to obtain and enforce proper patent protection for said improvements in all countries."

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Testimony of George O. Curme, Jr.

Thereupon—

GEORGE O. CURME, JR., a witness of lawful age, produced on behalf of the Plaintiff in rebuttal, having been first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION BY MR. WATSON:

Q. What is your position and occupation, Doctor Curme? A. Vice President and Director of Research for the Carbide and Carbon Chemicals Corporation.

Q. Are you a chemist? A. I am.

Q. Please indicate briefly some of the honors which you have received in recognition of your ability as a

[864]

chemist? A. I received the degree of Bachelor of Science at Northwestern University in 1909. I received the degree of Doctor of Philosophy in Chemistry from the University of Chicago in 1913. I was a Fellow at the Mellon Institute for the period from 1914 to 1920. I have been employed by the Carbide and Carbon Chemicals Corporation since its formation in 1920 to the present time.

Q. I think we can sum it up, I am sure the defendant will not object on the ground of a leading question because it will perhaps be less embarrassing to you. Your accomplishments as a chemist have been recognized, have they not, among other ways in the tribute of American Industry given this past winter, giving medals to the outstanding American Pioneers in Chemistry? A. That is correct.

Q. And you were included as one of the nineteen recipients for such an honor? A. That is correct.

Q. Doctor Curme, were you advised of Doctor Laws' February 1936 tests in passing ethylene and air over a silver catalyst to produce ethylene oxide, were you advised of those at the

[865]

time? A. I was.

Q. What conclusion did you draw from them with respect to the process under inquiry?

* * * * *

The Witness: I drew the conclusion that it was a

[866]

distinctly operable process and one of great commercial value.

By Mr. Watson:

Q. What action did you take at that time? A. I proceeded immediately to get in touch with the president of our company and my associates in New York and we at once began negotiations for the purchase of the American rights to this patent.

Q. Those negotiations were consummated in an understanding whereby you obtained them in March, 1936? A. That is correct.

Q. What did your company do with respect to the process from that time until you built your plant? A. We began immediately a program of development work to adapt this process to an engineering embodiment which would operate satisfactorily under the conditions existing in our West Virginia plant.

Q. What are these photographs which I hand you? A. These are photographs of our commercial units taken shortly after its completion, which completion date was in November, 1937. I notice these photographs are dated December 21, 1937.

[867]

Q. Has the plant been in operation since then? A. The plant has been in uninterrupted operation since then. We have doubled the size of its operation by engineering changes at one time which required a short interruption of operation.

Q. Can you tell us generally speaking whether the erection and design of such a plant involves a considerable amount of engineering? A. It does indeed. One of the important parts of my responsibility is the operation of the development department of the Carbide and Carbon Chemicals Corporation, the purpose of which is to adapt processes which we have invented in our research depart-

ment or which have been acquired from outside inventors to an engineering embodiment that can operate successfully on a large scale basis.

Mr. Watson: We offer these two photographs in evidence as Plaintiff's Exhibits 17 and 18.

(Two photographs of West Virginia plant marked Plaintiff's Exhibits 17 and 18.)

Q. You have spoken of your duties in the development

[868]

and translation of processes from the laboratory to large scale industrial production. Can you tell me in the light of that experience how the interval between March, 1936 and the commencement of the operation of the plant in November, 1937 compares with other instances of your development and engineering experience to put processes into large scale operation?

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A. This is the most rapid development and adaptation to commercial practice which our company has ever experienced.

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Q. You have been in the Court room during the trial? A. I have.

[869]

Q. I understood Doctor Reyerson to express the opinion that a process including the passage of ethylene and air, the air having added to it, water, irrespective of its amount, and passing that mixture over a catalyst of silver to produce ethylene oxide was chemically speaking entirely different from a process of passing ethylene and air over the

same catalyst to produce the same product. Do you agree or disagree with that opinion? A. I disagree with that opinion. To me, the two are identical.

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Q. From a chemical viewpoint? A. That is right.

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CROSS-EXAMINATION BY MR. BARROWS:

Q. On this last question, Doctor Curme, do you know what takes place at the surface of the catalyst when you

[870]

have present ethylene, oxygen and a large proportion of steam? A. From the standpoint of actual knowledge, no one knows. There are many engaging theories on catalysts and a great deal of valuable work on that subject is being done but if you are asking from the standpoint of absolute knowledge, I am sure that there is no absolute knowledge on this subject.

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[1250]

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Thereupon—

GEORGE O. CURME, JR. resumed the stand on behalf of the Defendant, and testified further as follows:

DIRECT EXAMINATION BY MR. BARROWS:

Q. Doctor, do you recall that in this affidavit which you filed, or which was filed in the Patent Office in connection

with Lefort Reissue Application, you referred to the Willstatter and Bommer article, and the work which was done under your supervision shortly after that article appeared. A. I did.

Q. Now, I read from your testimony in the pre-trial deposition, and ask you if that is your testimony now. Page 42.

"Q. Do you recall what temperatures were used in those experiments carried out under your direction

[1251]

after the publication of the Willstatter and Bommer article? A. No, I do not recall except I feel very sure we were employing substantially the same temperatures as were recorded in the Willstatter and Bommer article.

"Q. In your affidavit you said that 'Willstatter and Bommer reported that oxidation catalysts in general lower the temperature at which effective oxidation of ethylene with molecular oxygen takes place.' Is that something which was confirmed by the experiments carried out under your direction? A. Yes.

"Q. Then you say in your affidavit: 'The lower reaction temperature would be expected to be favorable especially because some of the oxidation catalysts were known to be effective in producing formaldehyde by the oxidation of methanol.' What were the oxidation catalysts that you were referring to as catalysts known to be effective in producing formaldehyde by the oxidation of methanol? A. Copper and silver have been used rather

[1252]

extensively in the production of formaldehyde from methanol.

"Q. Copper and silver were well known oxidation catalysts at that time? A. Yes.

"Q. And I believe you said that when you used silver and copper in those experiments carried out under your direction, after the Willstatter and Bommer publication, that you failed to get formaldehyde, or did you state what your results were? Did you obtain formaldehyde when you used copper and silver following the Willstatter publication? A. The only statement I recall is that we obtained substantially the same results as Willstatter, and Willstatter did obtain formaldehyde from ethylene with certain of his catalysts, and we did also."

Mr. Watson: There is a correction in the transcript there, Mr. Barrows. Put in an "if" before "Willstatter".

Q. (By Mr. Barrows) "And if Willstatter did obtain formaldehyde from ethylene with certain of his

[1253]

catalysts, we did also.

"Q. You say you did also? A. Yes.

"Q. And do you recall that you obtained it with silver? A. I would say at this time I can not recall which experiments were conducted at that time. I can only say that we did not discover ethylene oxide in our reaction products or any of the experiments which we conducted."

[1254]

"Q. Did you look for ethylene oxide in the products of that process? A. Not specifically, because we had no reason to anticipate that it would be there. However, we

had, for the time, good research facilities. My brother was a well-qualified organic chemist, and I feel sure that he would have recognized it had it been there in substantial quantities."

Is that still your testimony, Dr. Curme? A. Yes, as mentioned previously, when considered in the light of the various definitions and considerations that had been established earlier in the deposition.

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[1257]

Q. Do you recall any work that had been done under your direction in the laboratory of the plaintiff company in the use of different kinds of silver as an oxidation catalyst prior to this work? A. I previously referred to work done in the early 20's by my brother, H. R. Curme, in which he reported some work of Willstatter's in which silver was attempted as a catalyst. Silver had been abundantly mentioned in the chemical literature as a catalyst, and I feel sure that in our investigations on catalytic problems, silver must have been included among the materials examined.

"Q. Do you recall what kind of a silver catalyst your members used in the experiments on the Willstatter process? A. No, I do not recall the details of these experiments.

"Q. Do you recall any experiments in the use of silver gauze as a catalyst prior to these experiments that were discussed this forenoon being the first five experiments in Notebook, Defendant's Exhibit 8 for Identification?"

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[1258]

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Q. That is still your testimony is it, Dr. Curme?

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A. Why, yes, that is my testimony, which is to be taken in consideration with the conclusions which were reached that Willstatter taught us nothing regarding oxidation under the conditions described by Lefort.

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[1274]

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Thereupon——

GEORGE O. CURME, recalled by the Plaintiff, testified further as follows:

[1275]

DIRECT EXAMINATION BY MR. WATSON:

Q. You have heard the testimony, Doctor Curme about the McElroy patents? A. I have.

Q. Does your company own those patents? A. They do or they did up to the date of their expiration.

Q. When did you buy them? A. 1922.

Q. How many did you buy at the time? A. They were purchased with a group of some twenty odd patents acquired from the Commercial Research Corporation.

Q. Did you pay any substantial amount for them? A. The whole group of patents were acquired at a very low figure.

Q. Did they ever teach you how to produce ethylene oxide from that day forward? A. They did not. Technically, they were among our assets. We studied them to find out what, if any, their

[1276]

objects were and we considered them as completely valueless as regards teaching us anything about the manufacture of ethylene oxide without the use of chlorine.

Mr. Watson: That is all.

Mr. Edmonds: May I ask you to wait just a minute.

CROSS-EXAMINATION BY MR. EDMONDS:

Q. That is what you thought about the Lefort patents when you saw them, that they were inoperable, isn't it? A. Until we started to experiment.

The Court: That is all.

(Testimony of the witness concluded.)

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[834]

Testimony of J. C. W. Frazer.

Thereupon—

J. C. W. FRAZER, a witness of lawful age, called by the Court, having been first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION BY THE COURT:

Q. Dr. Frazer, did you witness any tests by either one or both of the parties since the Order of the Court? A. I witnessed——

Q. I do not mean for you to give me or tell me what they were, or the results, but just answer the question, did you witness any? A. I did, I witnessed one series of tests.
Q. Run where? A. In Charleston, West Virginia.

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[835]

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Q. (By the Court) Were representatives of both companies present? A. Yes, sir.
Q. And then, did you consider that was sufficient for your purposes in order to testify here? A. I considered it representative, yes,

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Q. (By the Court) They were run by whom, in your presence? A. They were run by the plaintiff.

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[1036]

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DR. J. C. W. FRAZER (recalled), a witness heretofore sworn, was recalled by the Plaintiff, examined and testified as follows:

Mr. Watson: Preliminarily, may I make two comments? I thought I indicated last night I would be glad to call Dr. Frazer. The second observation is that I really did not understand your Honor's order as you now indicate it with respect to our examination of Dr. Frazer, because that order, I thought, recited that the parties should put in their evidence, then Dr.

Frazer would be called by the Court and cross-examined by counsel for both sides. But, faint heart never won fair lady.

DIRECT EXAMINATION BY MR. WATSON:

[1037]

Q. Dr. Frazer, you have attended the trial? A. I have.

Q. You have heard the testimony? A. I have.

Q. In the course of the evidence a difference of opinion has arisen between the witnesses on the two sides with respect, generally, to two topics; the first one, as I understand it, is as to the adequacy of disclosure of the original and reissue Lefort U. S. patents for the purpose of teaching one skilled in the art how to make a silver catalyst which could be placed in a confined reaction zone and over which could be passed a mixture of ethylene and air to produce ethylene oxide, without the formation of substantial amounts of aldehydes. What is your opinion on that subject?

First, may I qualify you a little more on it by saying that you also attended a demonstration in South Charleston in plaintiff's plant? A. I did, as I said yesterday afternoon.

Q. (Mr. Watson) Oh, yes. And I should have included in my prior question that this process was to be

[1038]

conducted at a temperature within 150 to 400 degrees in the reaction zone. That was a further qualification. Now, what are your views on that subject? A. Well, the question, as you state it briefly, is what would I do to prepare a silver catalyst that would work according to the directions as I would find them in the patents?

Mr. Watson: That is a paraphrase of it.

A. Well, I would proceed exactly, I think, as Professor Lamb did, or, at least, my mental operation would be that.

I would assume that an active silver catalyst was needed, a highly active silver catalyst. Now, I know that there are cases where a catalyst may be too active; one of those is in the catalytic oxidation of ammonia, but I certainly would not consider that here in the first instance.

I would think that I needed a very active catalyst, and I know from all of the work that I have done on catalysts that that material would have to be finely divided in order to have this catalytic activity I spoke of.

[1039]

Now, I know that the best way to get silver in a finely divided condition would be to precipitate some insoluble salt of silver from which catalytic silver could be readily obtained after it was dried or cut into proper shape.

Now, two of those compounds have been mentioned here, two of the three that I would think of at once: silver oxide, which was the starting point in the preparation of the catalyst at the demonstration at South Charleston; and silver oxalate, which has been mentioned in connection with another patent spoken of in this case; a third compound which I would think of, would have been the carbonate.

Now, any of those three compounds will enable you to prepare silver in a very finely divided form.

[1040]

In the case of the oxalate and the case of the oxide, as Professor Lamb carried it out, you can go directly by heat to the metallic silver but at Charleston this was done by reduction in hydrogen. Now, just stepping aside for a minute, that method of using the oxalate has been pat-

ented, I think, if I am correct, and that is a very common thing. One can precipitate as oxalate any metal whose oxide is readily reduced and by careful heat go from the oxalate to the finely divided metal. That is done by most students in the laboratory. They prepare various oxalates, dry them, heat them; they go to a finely divided iron which takes fire when exposed to the air and is called pyrophoric iron. Nickel is the same way and it has been used as a means of preparing nickel catalysts in finely divided condition and the same is true of the silver which is the most easily reduced oxide of any of these metals, so that to come back to where I started, this would be one of those and I would not be able to make any choice in the beginning. I think any of them would work, would be a starting point for the preparation of finely divided metallic silver which I would know and would be perfectly sure would be required. Does that answer

[1041]

the question?

Mr. Watson: Yes, I think that answers the question.

By Mr. Watson:

Q. You speak of the use of the silver compound oxalate and said as I understand you, that its reduction to silver was familiar routine to students? A. Yes, you find it in the text books.

Q. How long has that been rudimentary common knowledge? A. That is an old observation. I don't know how long it goes back.

Q. Does it go back ten years? A. Longer than that, I think it would go back——

Mr. Edmonds: It is enough if you say more than twenty years.

The Witness: Yes.

Mr. Edmonds: You need not strain yourself.

The Court: Wouldn't we get along a lot faster and better if Doctor Frazer told us what he witnessed and then whether he thinks what was done follows the teachings of the

[1042]

patent, and whether the patent was sufficiently descriptive to enable those that perform the experiment to get good results? That is what we want?

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By Mr. Watson:

Q. You heard the testimony of Doctor Law describing the demonstration in South Charleston? A. I did.

Q. Just for brevity of record, it is not necessary to repeat too much of that unless you wish to express some further details about it, but I would be interested in yielding you the floor entirely, Doctor Frazer, and let us hear the opinions which you hold with respect to that operation and with respect to the adequacy of disclosure of the

[1043]

patent and with respect to this question of variance between the original and Reissue? A. I think, your Honor, that you really do want to know about these tests at Charleston, so I will go into those.

Q. Yes, if you please. Will it help you if we bring up the model? A. I think it will save time probably. We

arrived in Charleston, I think, about eleven o'clock or a little before eleven at least.

The Court: Would you talk a little louder.

The Witness: When we arrived in Charleston, we went directly to the laboratory on the morning of the 29th of May. When we arrived we were told that an experiment was already in operation and it had been in operation a matter of a few days, four days, as I remember the number. That experiment, the apparatus used, we were informed, was essentially in its details a duplicate of this apparatus here with the exception of two points; one of those was that the tube on this first apparatus which was in operation, the tube which contained the catalyst itself was metal and not

[1044]

glass, and this metal tube was immersed directly in a heating fluid for better temperature control.

I jotted down some figures that were given on the analyses there during the course of this experiment and possibly could be identified in the sheets that have been submitted of these tests that were made there.

In this first apparatus, the first analysis, I have here was on a sample of gas which contained 19.9% of ethylene and so on. The catalyst bed was at a temperature of 226°. The exit gases contained 7.6% of CO_2 and 15.4% of ethylene and the calculated efficiency was given to be 34%. The second run some time later was made on a sample of gas containing less ethylene. In this gas the incoming gas contained 10.1% of ethylene and the exit gases contained 5.3% of CO_2, 5.8% of ethylene and the temperature was 235 and the efficiency was about 37%. Now, that apparatus was then connected up so that the ethylene which was being generated could be frozen or collected by refrigeration.

Mr. Watson: You mean the ethylene oxide?

The Witness: The ethylene oxide, I beg your pardon, so that the ethylene oxide which was being made in the course of this experiment could be liquified and examined at a later

[1045]

time of the day. That was done for that purpose. Then, this last apparatus was put into use and we were shown exactly how this catalyst was prepared. In fact, the catalyst was prepared there before us. A certain amount of this material Filtros was weighed out, a certain amount of silver nitrate was weighed out and dissolved. The silver was precipitated with a slight excess of caustic soda and washed twice, I think, with water. After the silver oxide had settled from the solution, the solution was poured off, decanted. That was done, I have the number of times, but it must have been ten times, it was continued until the wash water which was being poured off was no longer alkaline and showed the absence of the small excess of caustic soda which was the test for complete washing of the precipitate. That was a preparation, we might say, a suspension of the silver oxide. That was then poured into the weighed sample of Filtros in a porcelain dish, placed on a heater, slowly evaporated and stirred in the meanwhile so as to be sure that this silver oxide when it was dried would be on the surface of the Filtros.

The figures I have as given here before for that

[1046]

particular catalyst would have contained 32 % of silver. That catalyst prepared in that way, after drying, was put in a tube, either this tube or one just like it by placing some

of the untreated Filtros on the bottom so as to have all of the parts that contain the catalysts at a reaction temperature and then the catalyst was poured on top and the tube filled up with a blanket of Filtros just as it is there and then instead of decomposing the oxide by heat alone, as Professor Lamb did yesterday, hydrogen was passed through that tube. It took about three and a half hours as I remember, to reduce completely that oxide. The temperature was 200, or a little above at the end of which time the hot zone which marks the place where hydrogen is reduced to oxide could be followed gradually down through the catalyst bed by moving the thermo-couple junction, and when the heat zone passed out the bottom the catalyst was completely reduced. Two runs were made on that catalyst. The first at 185 degrees, when the inlet gas contained 2.1% ethylene, the exit gases contained 1% CO_2 and 1.3% ethylene, and I was given the efficiency as calculated to be 31.5%.

The second run on that same catalyst was made at a temperature of 179 degrees and on which the inlet gases had

[1047]

4.9% ethylene, the exit gases 4% ethylene and 1.2% CO_2. I was given a calculated efficiency for that experiment of 38% and at this time, that was pretty late in the day, this first experiment which had been allowed to run and accumulate the ethylene oxide was opened and while there wasn't a large sample there, it was ample to demonstrate that ethylene oxide had been prepared. We all examined it, two cubic centimeters.

By the Court:

Q. What was the conversion rate of that, do you know? A. It was part of the test that had been going

on, as I gave the first two analyses that were taken from that run as it was going at the time when we arrived.

Q. I mean, would you say it was commercially satisfactory or not, applying the same— A. As far as I know the technical requirements, I should say yes.

Q. Applying the same percentage test to Professor Lamb's experiment and the others, what was the conversion? A. The efficiency was 34% and 37% on these two experiments.

[1048]

Q. Was the result as efficient in the experiment under the large operation as it was under this specially prepared experiment? A. These two experiments were practically the same scale.

Q. They were? A. Yes, that is practically, I was told, we did not see it because it was in operation in an iron container and I was told this was a duplicate in essential details of that apparatus. The only difference was that the first one was made of iron and this is of glass so you could see it.

By Mr. Watson:

Q. And you could see that the height was about the same? A. I might say one other difference. In this glass apparatus the catalyst tube is not immersed directly in the heating liquid but there was a space of, an annular space of a few millimeters of air in between, which prevented satisfactory temperature control.

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Q. Before the recess we were speaking of some figures. During the recess did you get those data? A. I have these data as given in Professor Lamb's report, and as given in the sheets that are in evidence here on the two experiments on the Charleston run, the day we were there at the laboratory.

Q. Yes, sir. The Court inquired as to what those data were. A. Well, these data, your Honor, represent the percentage of ethylene which is converted to ethylene oxide in the passage through the catalyst tube. They are the percentages of ethylene converted into ethylene oxide during the passage of the gases through the catalyst

[1053]

tube. And I find that those figures for the experiment which Professor Lamb reported are on the average quite a little above the corresponding figures in the Charleston test, both of them.

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[1064]

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By the Court:

Q. Then, wouldn't it have been possible within a day or two after my order was signed for each side to have had a model and to have had Doctor Frazer come to wherever the model was and run the gases through it and show him how it worked?

Mr. Fairbank: We did so within nine days after your order was signed.

The Witness: This order was on the 21st, I received it on the 21st.

The Court: You did substantially that for the plaintiff. The plaintiff did substantially that, but the defendant did not. Is that what I am given to understand?

The Witness: That is correct.

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[1073]

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By the Court:

Q. You have studied the patents, haven't you, doctor?

[1074]

A. Yes, I have.

Q. I would like you to give us your opinion as to the use of water, whether it is mandatory or discretionary in the Reissue patent?

[1075]

And in any event, whether you find that there is any material departure in respect to water or anything else in the reissue patent, from the original patent.

The Witness: Well, your Honor, as far as I could make out in regard to this question of water, it is a very much over-worked topic.

The Court: It is what?

The Witness: It is a very much over-worked topic. I can go through the whole thing, all the patents, and indicate what they have meant to me, if that is any help.

Q. (By Mr. Watson) What do you mean by it being an over-worked topic, Dr. Fraser? A. Well, it seems to me that the original French patents and their additions disclose sufficient information in regard to the effect of water, to show that the operation could be performed either with or without the deliberate addition of water to the entering gases.

In claim 5—not claim, but in Item 5 of the original of the French patent—and, remember, that that patent

[1076]

was taken out—

Mr. Fairbank: —729, your Honor, is the first one.

The Witness: That patent was taken out for the production of ethylene glycol. And in that operation you have the two steps performed in one; that is, the oxidation of ethylene and the combination with water.

Now, in order to carry out those two steps in one you must have water. But he says in Item 5 of that that if you omit water you can produce ethylene oxide alone. So that it seems to me that it goes right back to the original patent, that the use of water for the production of ethylene oxide would be considered optional.

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[1082]

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The Court: Dr. Frazer, do you want to say anything else about this water content?

The Witness: Well, aside from the two main reacting gases, which are ethylene and oxygen, there are three other gases, you might say, that have been dis-

[1083]

cussed. One of them is nitrogen.

Now, so far as this operation goes, nitrogen remains inert. It takes no part chemically in the reaction at all. All it is, it is a heat absorber, and tends to prevent explosion.

Now, when you come to carbon dioxide, that also is a diluent, and absorbs heat and prevents explosion; but it is one of the products of the undesirable reaction. And it has, in effect, a third effect: It tends to supress this undesirable reaction. That is one of the reasons why it is advantageous, I should say, to use CO_2 as the diluent rather than nitrogen, because it cuts down the amount of ethylene that is wasted by complete oxidation.

[1084]

When you come to water, as I see it, water does all that carbon dioxide does, but there must be a little water in the reactants to start that reaction, because if the statement in the patent is true—I have never tried it—if the gases are entirely dry, you get no reaction; so that I say that the evidence is that there must be a little water, and that amount is somewhere

between zero and twenty or twenty-five millimeters vapor pressure that you have in ordinary air.

[1102]

By Mr. Edmonds:

Q. In that third French patent he practically told the world that what he had been saying up to that point was necessary, is no longer necessary because of another in-

[1103]

vention he has made, that is true, isn't it? A. Which he had already made in 1931.

The Court: Gentlemen, this doesn't seem to me to be getting anywhere.

The Witness: I think it is haggling over words.

[1108]

Mr. Watson: Dr. Frazer, in the test demonstrated to you in South Charleston, it is my understanding that in the steel tube the entering gas mixture had a water vapor content of about 1½ per cent, and in the demonstration with the pyrex glass equipment the water vapor was about .4 per cent, about 4/10 of one per cent. Does that assist you in expressing an opinion on the effect of differences in the water vapor content?

The Witness: Well, Mr. Watson, my opinion is that the amount of water beyond a certain small critical amount would not make very much difference.

Mr. Watson: And you base that opinion upon what you saw in South Charleston, the consideration you have given to the patents, and your general experience?

The Witness: It is more on what I know about chemistry.

[1109]

* * * * *

The Court: You mean whether you get it through the air or put it in.

The Witness: It does not make any difference where you get it. And beyond that amount I do not think it would have made a great deal of difference what you do, because once you get it started you get water formed by the second reaction, which adds on to whatever you put in.

* * * * *

[1111]

By Mr. Edmonds:

Q. Let me ask you this: Have you had time here since last Monday, when the papers were produced, to find from the papers brought in here by the Dutch Shell people who practiced this process in association with the French people, what amounts of water they put in? A. No, I do not recall that. It is unfortunate that I did not get much of Mr. Pyzel's testimony. There was much I could not hear.

Q. Well, it is largely in the documents that were filed here. A. I told you that this morning.

Q. So you have had no opportunity to see that these documents show that the people who practiced that inven-

tion, under the instruction of the French people, put in water vapor up to more than sixty per cent of the total volume.

* * * * *

Well, all I can say is I don't see why they did it.

[1117]

* * * * *

We are dealing here with ethylene oxide which, to the chemist, is a somewhat peculiar molecule, because it is what we say is a strained molecule, to form this three-numbered ring, and for that reason it is unstable to the extent that it is strained in its formation and it may easily go to aldehyde or something else.

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[1120]

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The Court: I might as well state now, in order that you may know the way my mind is running, it seems to me that unless the defendant's experts can bring out, can give me a clearer illustration than they have done, or can convince me more than they have done, it seems to me that the weight of the testimony indicates what Dr. Frazer and Professor Lamb and Professor Stevenson have said, namely: that the question of water is a secondary one, and that to use it or not to use it is not a material departure; that in order to be successful in the experiment you probably have always got some water, and the amount of how much is a matter of pure experimentation. That's the way my mind is running now. If that is true, I should have

to hold that the reissue is a perfectly valid patent and is a clarification of the original patent.

The one other question being the question of the catalyst, I think it self-evident from the testimony here that there is a sufficient description.

. . . . . .

[1124]

By Mr. Edmonds:

Q. Doctor, I believe there is some further statement on this subject that you feel that you can make that will be helpful to the Court. Will you proceed with it? A. The testimony that I gave yesterday on this matter of validity was practically confined entirely to the question of water, and I either said or implied that in my judgment the amount of water or the manner in which it was added was not the important thing at all, speaking entirely as a chemist.

. . . . . .

[1133]

. . . . . .

By the Court:

Q. From the chemist's point of view, Doctor Frazer, what is the real difference between giving the wide

[1134]

range of catalysts which apparently are so well known to the art, what is the difference between doing that and providing an optional method of applying heat to a given process? A. Well, catalysts in many cases are very specific and this happens to be one of those cases where the catalyst chooses a reaction going in one direction.

Q. That is true, but it tells you what kind of catalyst in broad terms, it must have the catalytic characteristics of silver. Suppose that was said to be built in a certain way in order to get this desired heat applied in a certain way and then it gives you, however, certain alternate ways of building it providing you produce a certain temperature at a certain time or something like that, as a practical matter, what is the difference as long as silver catalysts are so well known? A. Well, in the future it may not be so. It may be something else that is discovered which will do this thing that is not silver.

Q. And yet has the characteristics of silver? A. Of this particular reaction, the characteristics.

Q. In other words, your real objection is to the

[1135]

phrase "having the catalytic characteristics of silver." You think someone may come along and find something that has no relation to silver but will have the characteristics of silver to produce this effect. A. In this reaction.

Q. You don't think that that argument is true of the language employed in claim 9 because there it has a composition of silver? A. There it is definitely stated to be silver.

* * * * *

By Mr. Watson:

Q. What you said, Doctor Frazer, is a bridge to be

[1136]

crossed when we get to it. Is that your point, some time in the future, the question may arise? A. It means building a new bridge.

Q. You mean maybe building a new bridge in the future? A. Yes.

Q. It is not a bridge that is already built? A. No, it is another bridge.

Q. So that inasmuch as the bridge will be built in the future, we will cross it, if at all, in the future? A. That is correct.

* * * * *

[1137]

Q. When we want to judge the matter of equivalence between silver and something that somebody may or may not find in the future, we will want at that time to have the evidence on the relationships of the two in all its chemical and practical phases, wouldn't we? A. We would have to.

Q. And likewise, the possible objection you have raised as to that language in claim 8 would not apply if that language is to be interpreted by the Court as meaning materials referred to in the specification of the patent itself, isn't that true? A. That is a right long question.

Q. Yes, I know it is. My point is if as a matter of law, the language in that claim is to indicate a surface catalyst of a material having the catalytic characteristics of silver, if as a matter of law that covers only the materials in the disclosure of the specification, then your objection would not apply, isn't that true? For example, osmium and thalium are not mentioned in the specification of the patent? A. Yes.

[1139]

* * * * *

Q. Considering the specification of the reissue, you agree, do you not, that it has been narrowed with respect to the number of catalysts recited? A. That is the fact, yes.

Q. Well, now, if, as a matter of law, that language in Claim 8 as to material having the catalytic characteristics of silver was held to mean the materials listed, as the Court pointed out in lines 47 and 48 of column 1, and lines 1 to 11 of column 2, then this

[1140]

possible objection which you have raised would not be applicable; isn't that true? A. If that is the interpretation, yes, because that is the way it appears in claim 9, it is silver.

Q. It seems so to me also. You were asked as to how you would have proceeded in making a catalyst, and you said you would have proceeded about as Dr. Lamb did. A. I think I mentioned three silver salts, that I think either one would work.

Q. And I think you mentioned that you would have transformed those salts into silver, either decomposing them by heat, or reducing them by hydrogen. A. I would have reduced by hydrogen.

Q. But both of those ways were old, common and well known, were they not? A. That is right.

Q. For more than ten years? A. That is right.

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[1143]

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Q. And you agree, do you not, that in the original United States patent it is disclosed to have water present in the reaction zone? A. Yes.

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[1149]

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By Mr. Barrows:

Q. Have you any explanation of why it is that that large result was obtained at Charleston and the small result was obtained by Dr. Lamb, using silver on the different carriers? A. Mr. Barrows, I think I said yesterday that the

[1150]

nature of the ethylene oxide would make it necessary for any one to look more carefully into the nature of the support than would ordinarily be the case, because, as I said, ethylene oxide is, to the chemist, or should be, a somewhat unstable molecule and it will not stand contact with any kind of a surface under the conditions in this catalytic chamber, so I think a neutral carrier would have to include its neutrality toward ethylene oxide or it would not survive in the experiment.

[1266]

The Court: Well, I would like to ask Dr. Frazer a question or two about that.

Thereupon—

J. C. W. Frazer (recalled), a witness heretofore sworn, was recalled by the Court and

[1267]

questioned as follows:

By the Court:

Q You have heard the testimony of Professor Taylor; do you agree or disagree with him with respect to the anticipatory character of the McElroy patents with relation to the patent in suit?

[1268]

A. I think I disagree with him.

Q. For what reason? A. Well, for one reason, these patents were taken out in 1918 and as far as I know there is no evidence that they have ever been used.

Q. Do you consider they are an insufficient disclosure to do what the patent in suit calls for? A. I don't think they are commercial operations.

Q. Do you mean to say that if you took the McElroy patent, either or both of them, that you could not work out a successful process for making ethylene oxide with a silver catalyst? A. That would be my answer.

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By Mr. Edmonds:

[1272]

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Q. Now, if you were practicing this McElroy process or attempting to do it, what is it that you would be lacking in your effort to practice it in the way of directions from McElroy which would embarrass you in your attempts to practice the process which you are told in the Lefort specification? A. Well, I think the two things that would rather stump me, to begin with, is the fact that he doesn't tell which of this class of labile oxides may be useful. In the second place he doesn't tell anything about the temperature range within which such a catalyst would be useful and it would probably be true that the temperature range would be different according to the particular one of these labile oxides you might select, so it would be a complicated thing to work out a combination that would give——

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[253]

Testimony of Lloyd H. Reyerson.

Thereupon—

LLOYD H. REYERSON, a witness of lawful age, produced on behalf of the Defendant, having been first duly sworn according to law, was examined and testified as follows:

[254]

DIRECT EXAMINATION BY MR. EDMONDS:

Q. Will you state your name and place of residence and occupation?

[255]

A. Lloyd H. Reyerson, my residence is Saint Paul, Minnesota. I am professor of Chemistry at the University of Minnesota.

Q. How long have you served in that capacity? A. Twenty-one years.

Q. Have you had occasion to give much thought and study to catalysts? A. I have spent a great deal of time studying catalysts. As a matter of fact, practically all of my research activity since I received my doctorate at Johns Hopkins University in 1920 has been devoted to the study of the effect of surfaces upon gases of various kinds.

[257]

* * * * *

Q. Now, the statement also is that the process is one of subjecting ethylene to the action, among other things, of oxygen of air. What can you say about that with respect to the amount of moisture content in it? A. Well, air is composed of a mixture of oxygen, nitrogen, inert gases, some carbon dioxide, and a variable quantity of water vapor.

* * * * *

[260]

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The Court: The application of water is a pretty common thing, isn't it, in a lot of processes. Is it necessary to a trained chemist, to tell how much water he should add to the process?

The Witness: No, I do not think it is essential at all, [to tell] how much water.

The Court: Then, would you say that the fact that the amount of water is not specified would make any difference?

The Witness: It is not a material difference.

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[265]

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By Mr. Edmonds:

Q. What is the purpose of the process described in this patent? Is it the purpose of producing ethylene oxide? A. Yes.

* * * * *

[278]

. . . . . .

Q. Will you state what is said there about the process to which this Reissue patent was directed? A. The second sentence of the first paragraph states, "It essentially consists in causing ethylene to combine directly with molecular oxygen at temperatures of about 150 degrees to about 400 degrees Centigrade in the presence of a surface catalyst which favors the oxidation of ethylene to ethylene oxide under these conditions." There is no mention of water in that particular paragraph and it mentions molecular oxygen, which in my opinion, means you could use dry oxygen. It does not have to come from the air. It could be the separate oxygen in which case the water content is but negligible; in other words, the statement does not require the presence of water.

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[286]

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Mr. Edmonds: And that the list of catalysts has been cut down from some astronomical figure to something very modest.

The Court: Now, what do you think is the effect of that? Suppose he had an option of catalysts, does that make much difference?

The Witness: Oh, it makes a tremendous difference.

[287]

The Court: Well, you have an option in both.

The Witness: Yes.

Lloyd H. Reyerson

The Court: But the option is simply very much smaller in the second one.

The Witness: That is correct.

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The Court: Well, now, that is evidently what has been attempted in boiling the number down in the claims.

The Witness: That is true.

The Court: Or, as a practical matter, that is a help rather than a hindrance, isn't it?

The Witness: Yes.

[300]

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The Court: But assuming that somewhere in that list you get your catalyst, as I understand it you think with that qualification the first patent does give you a workable specification?

The Witness: Yes.

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[690]

CROSS-EXAMINATION BY MR. WATSON:

[694]

Q. Since you studied either the original or the reissue patent, have you tried to make a silver catalyst for conducting the process? A. No.

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[697]

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Q. • • • you testify that the amount of water as far as the Lefort patent is concerned is not significant nor material. Now, do you mean that in your experimental work in 1926, however, the amount of water as distinguished from the presence of water would have been a very important and

[698]

essential and material factor? A. I think it would with our catalyst, yes.

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Q. • • • will you agree with me, as Doctor Taylor agreed that for all purposes of this question of water, we may confine ourselves to the condition in the reaction zone? A. Yes, if all of these conditions are considered in the reaction zone.

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[701]

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Q. Do you know whether there was published at the date of the issuance of the original Lefort patent that it was published knowledge that silica gel would transform ethylene oxide to acetaldehyde at such temperatures? A. I don't recall any such statement of the literature that silica gel itself would do that.

Q. If that should prove to be the case, it would indicate that silica gel was not a desirable inert support to be used in this process, isn't that true? A. Yes, but until it is proven that, I would not accept the statement that silica gel was not a good carrier.

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Q. It was not silver merely, your invention concerned platinum and in general, its subject matter was

[702]

metalized silica gel, isn't that true? A. That is correct.

Q. And you solicited a patent on that particular substance? A. Correct, that is correct.

Q. Do you know of any commercial catalytic process of oxidizing hydrocarbons where that catalyst of yours has ever been industrially used? A. No.

Q. Will you agree with me and with the prior witness who stated that in 1935, say, when the original Lefort patent issued, the literature indicated a variety of suitable inert supports that might be employed in such a process? A. Yes.

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[703]

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Q. Will you agree with the prior witness that it would have been common sense to select a support which had the necessary qualities of mechanical strength and surface to which the silver could adhere? A. Yes, I would.

Q. Now, I come to the question of your testimony on variance between the original and reissue patent and first, you went over the disclosure of the original patent as to water. I am not going to take you over in detail on that but I want to ask you whether for all the purposes of the cross-examination and for all the purposes of the

[704]

issues of this case, we may not, both with respect to the original patent and the reissue, we may not confine our

consideration on the subject of water to the ambit of the reaction zone? A. That is what you must confine it to.

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[705]

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Q. • • • I will ask you the question whether, in your opinion, the process can be conducted by the addition of water to the entering gas

[706]

mixture so that in the reaction zone all the ethylene oxidized is converted exclusively to ethylene oxide. A. I do not believe so.

Q. Have you the copy of the original patent in front of you? A. Yes.

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Q. Well, then, let us continue down on the same page to line 48, where he says, "the reaction of oxidation of ethylene into carbon dioxide will be completely checked." Those are the same words which you have just used. Do you think he was mistaken in that?

[707]

A. He was mistaken, but that actually applies also to the addition of carbon dioxide.

Q. And that language is omitted from the reissue, isn't it? A. As far as I know.

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[709]

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Q. Then, I go back to my question, and ask whether this omission in the reissue is not, in your opinion, as a practical thing, an improvement, beneficial? A. Well, I might admit that the elimination from the reissue of the addition of carbon dioxide to completely check the reaction might be considered as some addition, some simplification.

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[717]

Q. Dr. Reyerson, have you seen the operations as conducted on this process in the defendant's plant? A. Yes.

Q. How much ethylene oxide is there in the exit gas from the reaction zone, in per cent?

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[718]

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A. Well, I visited the plant in December of 1939; and I am frank to confess I don't remember the percentages now that were in the exit gas.

Q. The percentage of ethylene oxide in the exit gas relative to the percentage of water vapor in the exit gas did not impress itself on your mind as a matter of importance? A. Not at that time.

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[719]

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Q. Well, don't you think the words "considerably promotes" connotes that the reaction occurs even without that

water added? A. No, I would not necessarily feel that way.

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[720]

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Q. Take the next sentence, beginning at line 12, there it says "Oxygen can be oxygen of the air." Doesn't that indicate that the oxygen can be pure oxygen? A. Yes, it just tells you that you may add oxygen of the air. You must add oxygen.

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[723]

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Q. By the way, why did you omit reference in your direct examination to the 5th resume of the very first filed French convention patent 729952? I think your Honor might wish to look at that 5th resume? A. Would you state the question again?

Q. My question is why you omitted reference to that fifth resume in all of your direct examination? A. Because when you take the second addition of this same patent, it states that tests made by the applicant show that the catalyst indicated did not enable one to obtain ethylene oxide by the oxidation of ethylene if the gases are dry. In the first place, I was not asked about this statement. In the second place, I would consider in the light of this additional material it was pure speculation.

Q. Read into the record that fifth resume, please? A. "By avoiding the addition of water in the reaction one can obtain ethylene oxide".

Q. The subject of that first French patent was the production of ethylene glycol, wasn't it? A. That is correct.

[724]

Q. And that involved a combination between water and ethylene oxide? A. Yes.

Q. So that this fifth resume indicates that by avoiding the addition of water the glycol formation might not occur but that the ethylene oxide formation would occur, is that true? A. That is the speculation of it.

Q. That is the import of the statement, isn't it? A. Yes,

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Q. Now, the second addition to which you refer is

[725]

epitomized, isn't it, in the statement on page two of the translation "The presence of water is necessary for the production of ethylene oxide"? A. Well, that is certainly part of it.

Q. And we have already agreed that that means that the presence of water is necessary in the reaction zone? A. Is that right? The presence of water is necessary in the reacting gases.

Q. And the gases react in the reaction zone? A. They react on the catalyst.

Q. And the catalyst is in the reaction zone? A. Yes.

Q. Turning again to the original United States Patent, in the first column an equation is given, is that right? A. That is right.

Q. It appears from that, doesn't it, that in the formation of ethylene oxide, carbon dioxide is not a reactant with ethylene to yield ethylene oxide? A. Carbon dioxide?

Q. Yes. A. I don't see anything concerning carbon dioxide

[726]

reacting.

Q. And is it not true that from this equation it indicates that carbon dioxide is not one of the reactants? A. Carbon dioxide doesn't, according to this equation react into ethylene.

Q. And according to that equation, water does not react with the ethylene to give ethylene oxide, is that right? A. That is correct,

[727]

Q. In your direct examination I understood you to state that Claims 8 and 9 of the Reissue begin that the catalyst must be such as will not work in the presence of water. That is not just what you meant?. A. I am sure I never said that. At least, I would like to see that.

Q. Certainly. At least, that is not your opinion? I quote that answer from page 302 of the record. "In other words, the two, that is the original and Reissue, are different because the first requires water and the second does not, but you admit that the second may be a workable plan". That was the Court's question and your answer was "Yes, the first one requires catalysts which will operate in the presence of water and the second one requires catalysts that won't operate in the presence of water." A. Yes, because water is permissive in the second one and if it is to be operated without water, you must have a catalyst that will operate without water.

Q. But inasmuch as you say water is permissive, then in a case where that permission is availed of, it is not true that the claims require a catalyst that will not oper-

[728]

ate in the presence of water, isn't that right? A. It requires a catalyst that will not operate in the presence of water but may be operated in the presence of water.

* * * * *

Q. Turning again to the original United States patent on page 1, that speaks of the use of molecular oxygen, doesn't it? A. I don't believe I can find that statement about molecular oxygen.

Q. Look in the equation, doesn't that show O_2? A. As far as the representative equation is concerned, if shows O_2.

Q. And O_2 is the chemical symbol for molecular oxygen? A. Certainly.

[729]

Q. Is it not true of both the original and Reissue patents that ethylene oxide is formed in the reaction zone by the direct combination of only ethylene and molecular oxygen in the presence of the catalyst and in the presence of water and at a temperature between 150 and 400 degrees centigrade? A. Will you repeat that question?

(Question repeated by the stenographer.)

By Mr. Watson:

Q. I would like a yes or no answer which you can then explain if you wish.

The Witness: That is a very long sentence. I wish you would repeat it once more.

(Question repeated by the stenographer.)

[730]

A. My answer is "Yes"; but the two patents differ in the requirement of what shall be present when the reaction occurs. The statement as read gives no evidence of what is happening on the catalyst surface, and that must be speculation.

Q. Well, we, of course, can not get inside the reaction zone, and we do not want to speculate about it. A. No, but that is the key to the thing.

Q. But as far as the process of operation procedure is concerned, your answer to that question was in the affirmative. A. Yes, the end product, one of the end products is the formation of ethylene oxide.

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[733]

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Mr. Edmonds: I offer in evidence a copy of the article written by Dr. Reyerson and his associate Dr. Swearingon, published in the Journal of the American Chemical Society, in the Volume for July-December, 1928.

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[1183]

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Thereupon—

LLOYD H. REYERSON, a witness heretofore sworn, was recalled by the Defendant and examined and testified as follows:

CROSS-EXAMINATION BY MR. WATSON:

* * * * *

[1189]

* * * * *

Q. From the chemical viewpoint, isn't it true that the sine qua non of the process is that water shall always be present in the reaction zone? A. If the side reaction occurs water will always be present in the reaction zone.

Q. And so far as you know the side reaction will always occur? A. It usually does.

[1015]

Testimony of Walter Wilkinson.

Thereupon—

WALTER WILKINSON, a witness of lawful age, produced on behalf of the Defendant, in surrebuttal, having been first duly sworn, was examined and testified as follows:

* * * * *

[1026]

CROSS-EXAMINATION BY MR. WATSON:

Q. Are you a laboratory man? A. I have done work in the laboratory.

* * * * *

[1027]

A. I am a research man, and I am in the Research Department. I am not an operator.

* * * * *

[1314]

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Testimony of Ray M. Carter.

Thereupon——

RAY M. CARTER, a witness recalled by the Defendant, testified further as follows:

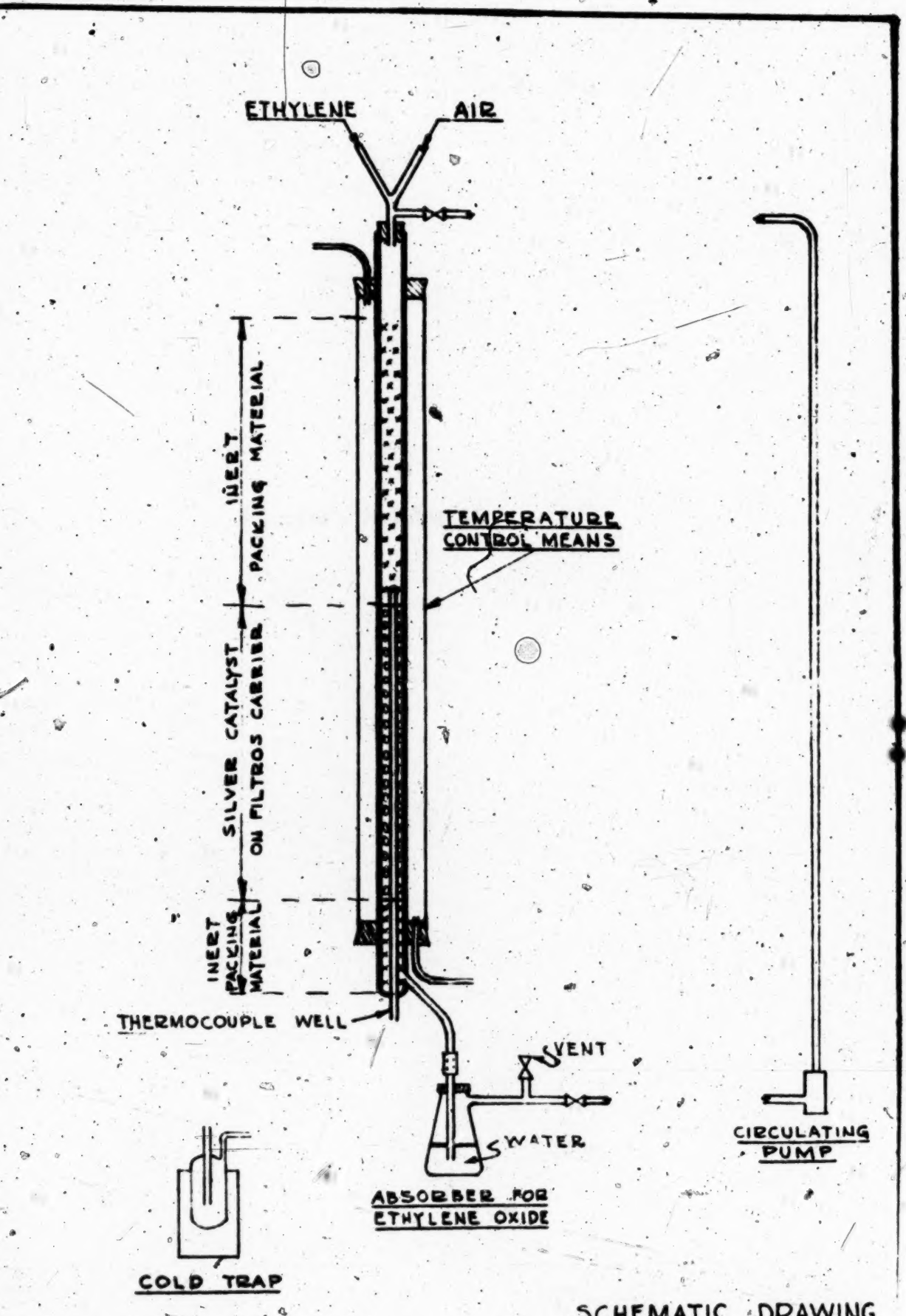
Mr. Barrows: In order to save time, and in accordance with the agreement last night, we wrote out the

[1315]

direct examination of the witness and furnished it to the other side last night. And it is stipulated that this may be written into the record as the direct examination, in lieu of taking the time to call the witness this morning.

The Court: Very well.

Plaintiff's Exhibit 4.



SCHEMATIC DRAWING
LEFORT PROCESS

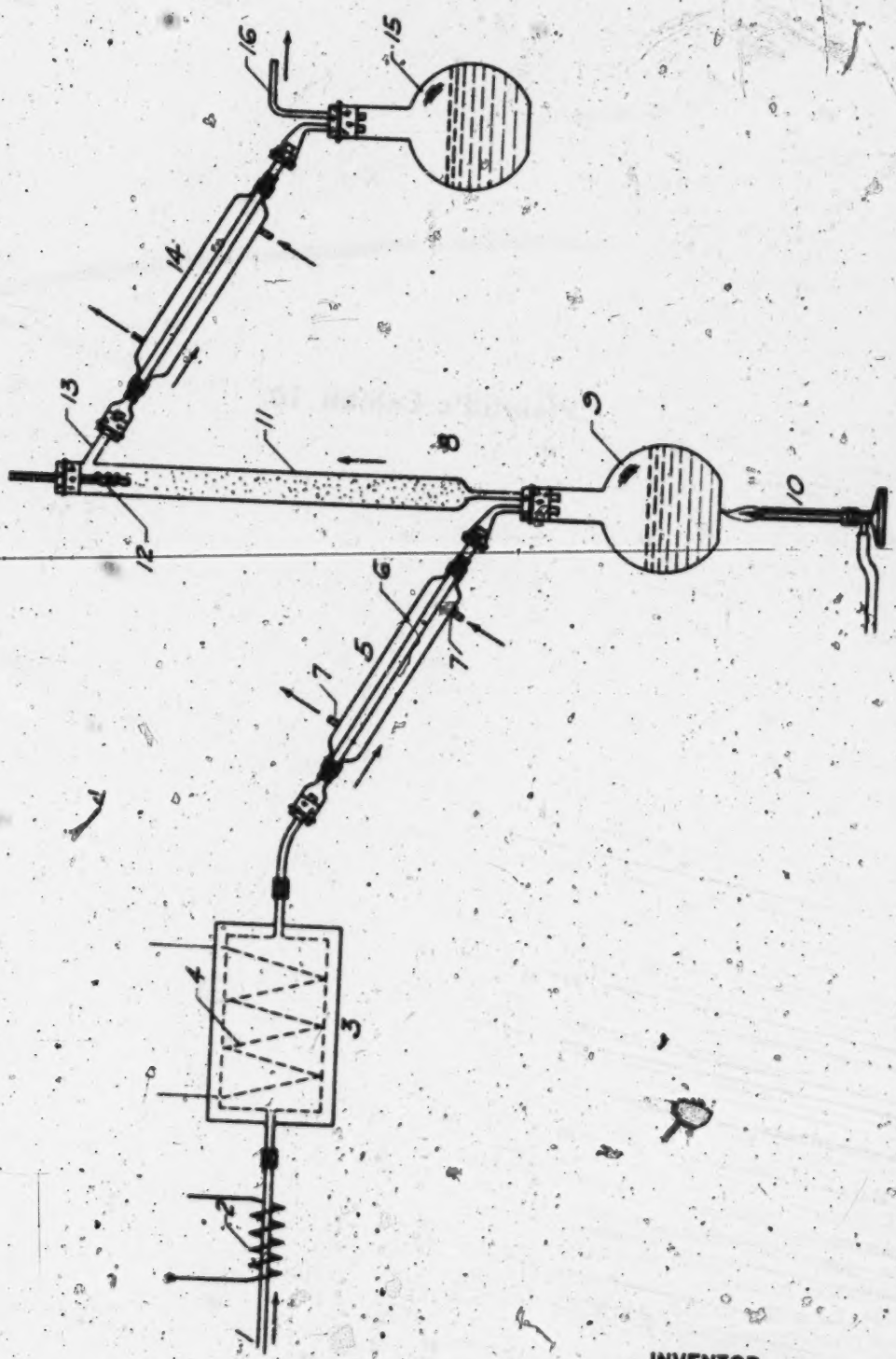
Plaintiff's Exhibit 10.

Plaintiff's Exhibit 10 (continued).

Aug. 8, 1939. H. S. TAYLOR 2,168,590

CATALYTIC ALKYLATION OF AROMATIC HYDROCARBONS

Filed Dec. 7, 1935



INVENTOR
Hugh S. Taylor
BY
Virgil F. Dawes
ATTORNEY

Plaintiff's Exhibit 10 (continued).

Patented Aug. 8, 1939 2,168,590

UNITED STATES PATENT OFFICE

2,168,590

CATALYTIC ALKYLATION OF AROMATIC HYDROCARBONS

Hugh S. Taylor, Princeton, N. J., assignor to The M. W. Kellogg Co., New York, N. Y., a corporation of Delaware

Application December 7, 1935, Serial No. 53,298

9 Claims. (Cl. 260—671)

This invention relates to catalytic processes of chemical synthesis and more particularly to processes involving the alkylation of organic compounds. More specifically, the invention relates to the production of valuable compounds by the direct reaction between less valuable materials composed preponderantly of the constituents of the desired compound under the influence of a suitable catalyst and under milder conditions than those employed in the prior art.

In the synthesis of many organic compounds the reactions involved are often of a very complex nature and the production of the desired product is achieved only by a multiple step-wise procedure usually involving the formation of numerous intermediate products and very often the formation of undesirable byproducts of little value resulting not only in a high manufacturing cost but also in a relatively low yield of the desired product. Moreover the operating conditions are sometimes of a drastic nature, often necessitating high temperatures, unusual pressures, or other features requiring costly equipment which may be subject to rapid deterioration due to one or more of the steps in the manufacturing procedure. As a result of these and other considerations it is a not unusual situation that the high cost of certain products precludes their general use for purposes for which they are eminently suited and where their employment, if not barred by the element of excessive cost, would be of great benefit to those so employing them.

The present invention has for one of its objects the provision of a simple and economic process for producing many desirable organic compounds which involves a minimum of procedural steps, employing relatively simple and inexpensive equipment, and requiring operating conditions considerably less drastic than those ordinarily necessary.

In the operation of my invention I accomplish the direct alkylation of many organic compounds, or in certain cases inorganic compounds, in a single step under unusually mild operating conditions with a relatively high yield of the desired product and with a minimum production of byproducts of lesser value. By the term alkylation is meant the substitution of radicals or alkyl groups for one or more of the hydrogen atoms or other atoms or radicals of a molecule, or it may mean the addition of such groups at the double bond or bonds, or triple bond or bonds, of a molecule, where such bond or bonds occur, without the displacement of any of the original components of the molecule.

To cause the desired reaction to proceed I choose a catalyst and operating condition such that I secure the activation of specific bonds in the reacting materials, the bonds being those which will, when activated, result in the desired reaction. This specificity of a catalytic surface will be made clear by the following very simple example made possible by the use of deuterium ("heavy hydrogen") whereby it is possible to note the exchange of hydrogen atoms in a molecule or, in effect, to label the atoms, a procedure obviously impossible before the discovery and isolation of this material. When ethane and deuterium were passed together over a given nickel catalyst at a temperature of 135° C. there occurred a replacement of hydrogen atoms in the ethane molecule by deuterium atoms, the replacement being substantially complete after an hour, the products being "heavy ethane" and hydrogen. This interchange of atoms would of course be undiscernible except for the use of deuterium. When hydrogen and ethane are similarly passed over the catalyst at this temperature the products are identical with the feed and there appears to have been no reaction, whereas in actuality there may have been a large scale interchange of atoms of hydrogen between the original ethane and the hydrogen. By the use of deuterium however, it is now possible to state definitely that such interchange has occurred thus showing positively the activation of the C—H bonds in the ethane. When, however, ethane and hydrogen were passed over the same catalyst at a temperature of 200° C. the dissociation of ethane occurred by the breakage of a C—C bond, resulting in the production of methane, thus,

$$C_2H_6+H_2 \xrightarrow{Ni} 2CH_4$$

This reaction was substantially complete, i. e., total conversion of C_2H_6 to CH_4, after about an hour. The reaction producing methane was first detectable at about 150° C. Thus it is quite evident that, with an active nickel catalyst, whereas at 135° C. the C—H bonds of ethane are activated, at 200° C. the C—C bonds are in addition activated, thus illustrating the specificity of the activation of the bonds by the catalyst. It appears almost needless to note that neither of these reactions can be detected at the temperatures used in the absence of the catalyst.

Other examples of the activation of certain bonds as detected by the use of deuterium are

Plaintiff's Exhibit 10 (continued).

the replacement of H atoms in benzene by deuterium at 200° C. over nickel, and over chromium oxide gel at somewhat higher temperatures and similarly the replacement of hydrogen atoms in CH_4 and NH_3 under conditions under which it was supposed that these materials were quite inert.

Having selected the catalyst and the operating conditions favorable to the activation of the desired bonds in the reactants involved it is now only necessary to contact the materials with the catalyst under the selected operating conditions and, after allowing the necessary reaction time to elapse, to withdraw the products, cooling, condensing, and otherwise handling these products as may be appropriate.

In order to make more clear the operation of my invention I will describe by way of illustration, but not of limitation, a specific embodiment of my invention whereby benzene and ethane are reacted to produce toluene according to the equation:

$$C_6H_6+C_2H_6 \xrightarrow{Ni} C_6H_5CH_3+CH_4$$

It will be observed that this reaction involves the alkylation of benzene by the substitution of a methyl group (CH_3) for one of the hydrogen atoms of the benzene, methane being produced as a byproduct in addition to toluene, the amount of this byproduct, however, being less than 15% by weight.

In the discussion of the specificity of catalytic surfaces, it was pointed out that at for example 200° C. active nickel activates C—C bonds of ethane and C—H bonds of benzene. It is readily seen that this catalyst and temperature may be employed to carry out this reaction. The process may be carried out at atmospheric pressure, subatmospheric, or superatmospheric pressure. For convenience and simplicity I prefer now to operate at substantially atmospheric pressure.

Referring now to the drawing, the single figure of which represents a form of apparatus suitable for carrying out the invention, a mixture of benzene and ethane is introduced at pipe 1 from a suitable container or compressor (not shown) and passes through a heating zone 2, diagrammatically shown. The heated mixture then passes into the insulated catalytic chamber 3 which contains the catalyst mounted preferably in pellet form on any suitable material as, for example, pumice or kieselguhr. The temperature of the catalyst chamber 3 may be maintained and controlled by means of the temperature regulating coil 4. The temperature and pressure at appropriate points in the apparatus may be determined by suitable instruments (not shown) installed wherever desired. The reacted product passes from the catalyst chamber through the cooler and condenser 5, furnished with a cooling medium jacket 6 having cooling medium entrance and exit 7. The greater portion of the condensible portion of the material passing through the condenser 5 is liquefied therein and the condensed material and uncondensed vapor and gas pass together into the fractionating equipment shown generally at 8. This equipment consists of condensate accumulator 9 which may be heated for reboiling by burner 10. Accumulator 9 may be provided with means (not shown) for periodically or continuously withdrawing condensate. Fractionating column 11 of any suitable design fractionates the vapor passing upwardly through it in the usual manner and may be furnished with reflux condensing coil 12 at its upper end and vapor outlet 13. The vapor passing through the outlet 13 passes to the condenser 14, similar to condenser 5. Condensate and uncondensible gases pass from the condenser 14 to the receiver 15 in which the condensate is accumulated, uncondensed gases passing out through tube 16 to an appropriate gas handling arrangement (not shown). The receiver 15 may be furnished with means (not shown) for withdrawing condensate as desired.

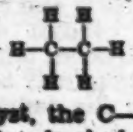
The raw materials, benzene and ethane, may be fed to the apparatus in any desired proportion, as for example in about equal molecular proportions or an excess of benzene may be used to insure the substantially complete conversion of the ethane, or, if desired, an excess of ethane may be used. Thus I may so proportion the feed that it contains two mols of benzene for each mol of ethane. The feed thus introduced is heated on its passage to the catalyst chamber to the desired degree, preferably in the neighborhood of 200° C. As noted hereinbefore the specificity of the particular catalyst cited, i. e., an active nickel, for the activation of the C—C bond of ethane was first noticeable at a temperature of about 150° C., therefore that temperature is the lowest at which the process is operable with such a catalyst. Also the process may be carried out at a temperature as high as 300° C. or higher but as already stated the preferred temperature is in the neighborhood of 200° C. It is to be understood that it is possible to carry out this reaction with different catalysts, those in the group classed as hydrogenation-dehydrogenation catalysts being generally suitable. None of these catalysts necessarily exhibits the same degree of catalytic effect at a given temperature as any other and for this reason different temperatures and rates of conversion would be used with a different catalyst. The specific operating conditions cited for the particular example described apply only for the catalyst cited and are not to be regarded as limiting conditions.

The free space within the catalyst chamber 3 is such that, for the given rate of feet, the reacting materials are maintained in contact with the catalyst for a period of time sufficient to allow the reaction to go forward to the desired extent. Under the conditions hereinbefore noted a reaction time of one hour, more or less, is satisfactory although, depending on conditions, a reaction time of two to five seconds or more may be sufficient while under other conditions a reaction of three hours or longer are desirable.

The material effluent from the catalyst chamber passing to the condenser 5 is composed of the desired product toluene and the byproduct methane in substantially equal molecular proportions along with any unconverted benzene and ethane. The liquefiable portions of this mixture, that is to say, the toluene and benzene, are largely condensed in condenser 5 although it is not essential that such liquefaction be entirely complete. The function of the fractionating apparatus 8 is to accomplish the separation of the product toluene from the more volatile benzene which has escaped conversion, as well as from any dissolved gaseous ethane and methane. The operation of such apparatus is well known and in this case toluene is recovered as a condensate in receiver 9 while the benzene and fixed gases pass overhead in vapor form through the outlet 13 to the condenser 14 where the benzene vapor is substantially completely liquefied, the liquid benzene being collected in the receiver 15. The

uncondensed material comprising the byproduct methane and any unconverted ethane are conducted away from the system by means of the tube 16 for such subsequent treatment as may be desired. The benzene collected in receiver 15 may be reintroduced into the feed to the apparatus following the customary procedure of recycling unreacted portions of a feed stock. As already noted it is preferable in this process so to proportion the feed that an excess of benzene is present in order to further the substantially complete conversion of the ethane since the recovery of unconverted ethane substantially free of methane is accomplished with difficulty. Depending on the thoroughness of the fractionation in this apparatus, the toluene may be recovered from receiver 9 as a substantially pure product or it may require subsequent purification by any suitable process.

As to the mechanism by which reactions of this type proceed, theoretical considerations and intensive study of catalytic phenomena in general, carried on over a considerable period of years lead me to believe at present that the reactions follow the course briefly outlined below. For the purpose of clarity the discussion will be confined, at the start at least, to the specific reactions of benzene and ethane. As already described, I have found that where ethane and hydrogen are passed over an active nickel at about 200° C., complete decomposition of the ethane to methane occurs. I believe that the ethane is chemically adsorbed on the surface of the catalyst in an activated condition in which the C—C bond is specifically activated. That is to say, when the ethane molecule

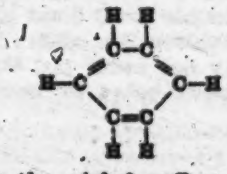


contacts the catalyst, the C—C bond is broken and the material is adsorbed on the surface as two methyl (CH_3) radicals, thus:

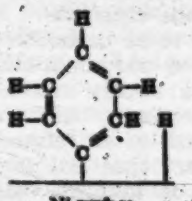
It may be considered that a methyl nickel complex is formed. Similarly hydrogen (H_2) on contacting the nickel surface is adsorbed in an activated state as two atoms of hydrogen. When ethane and hydrogen in mixture are thus adsorbed, we may picture the adjacent adsorbed fragments thus:

Under the conditions imposed there is a continual interaction between adjacent adsorbed radicals; thus it becomes apparent that adjacent CH_3 and H groups may readily unite to form relatively stable methane (CH_4) molecules which would thus appear as a product. It is also apparent that interaction between adjacent CH_3 groups may occur, but this merely regenerates C_2H_6 and interaction between adjacent activated H atoms merely regenerates H_2.

With regard to the activated adsorption of benzene on the same catalyst under like conditions, it has already been pointed out that in this case it is the C—H bonds of the benzene molecule that are activated, as shown by the experiments with deuterium. This type of activated adsorption may be pictured thus. The benzene molecule,

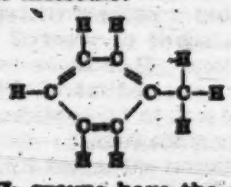


on contacting the nickel suffers a rupture of a C—H bond whereby a C_6H_5 radical and an H atom are adsorbed on the catalytic surface:



This type of adsorption is demonstrated by the fact that when deuterium is present, deuterium is found to be substituted for H in the molecule.

This rather detailed discussion is included by way of substantiating my theory as to the mechanism of the ethane-benzene reaction. In the light of the above it becomes rather simple to account for the production of toluene and methane from benzene and ethane under the influence of the catalyst. The ethane is adsorbed in an activated condition as CH_3 radicals and the benzene is adsorbed as C_6H_5 radicals and H atoms. Thus adjacent CH_3 and C_6H_5 groups will occur with a frequency dependent on the relative concentrations of the two materials on the surface, and reactions therebetween are to be expected, forming the toluene molecule:

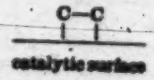


Also H and CH_3 groups have the opportunity to react to form methane and free energy calculations indicate that the joint occurrence of these two reactions is favored. The formation of diphenyl by the interaction of two adjacent C_6H_5 groups with simultaneous formation of H_2 is not favored by the free energy relationships involved, nor is the formation of ethyl benzene, and the presence of these products has not been noted in the end products of the reaction. Interaction between adjacent CH_3 groups will, of course, merely regenerate ethane and interaction between adjacent C_6H_5 and H groups results in the regeneration of benzene.

This reaction as above described is illustrative of the type of reaction broadly included within the scope of my invention and is characterized by the activation of specific bonds at catalytic surfaces and the reaction between the thus activated residues derived from distinct compounds to form specific desired products. The reaction detailed above is one wherein a C—H bond in one of the reactants is activated and a C—C bond in the other is activated and the residues thus activated interact to produce the desired product. Depending on the materials used, the catalyst, and conditions employed, any specific type of bond in one material may be activated and another specific bond in the other may be acti-

Plaintiff's Exhibit 10 (continued).

vated, that is to say, the bonds involved may be C—C, C—H, C—N, C—O, O—H, N—H, etc. In the case of the double C=C bond and the triple C≡C bond the situation is modified in that complete rupture may not occur but the bond may be activated as shown below for double bond:



so that a product is formed by the addition of an activated residue at each of the free bonds, i. e., those bound to the catalyst.

It is of course to be understood that products cannot be formed indiscriminately without regard to the free energy relationships involved and that it is necessary that the free energy of the products must be so related to that of the reacting materials that the production of the desired product is favored. Because of these free energy relationships, the temperature required for purely thermal activation of the reacting materials is, in a great many cases, of such magnitude that the free energy change of the desired reactions is unfavorable, whereas it is possible to carry on such reactions utilizing the specific activation by the catalytic surface at a lower temperature, where the free energy change of the reaction favors its completion. Thus it is clear that the specific activating properties of the catalyst make possible the carrying out of many desirable reactions, which could not otherwise be conducted at any temperature in the absence of the catalyst, whereby the usual conception of the action of a catalyst in merely lowering the reaction temperature is modified to include making possible reactions which could not otherwise be made to proceed.

Below are listed a number of typical reactions which may be caused to proceed in accordance with my invention. It is to be understood that these examples are cited merely by way of illustration and are not to be considered as limiting the scope of my invention.

Reactions between saturated hydrocarbons:

$$C_{n_1}H_{2n_1+2}+C_{n_2}H_{2n_2+2}=2\frac{C_{n_1+n_2}H_{2n_1+2n_2+2}}{2}$$

or

$$=C_{n_1+n_2-1}H_{2(n_1+n_2)}+CH_4$$

Reactions between paraffins as shown above by these general equations may be caused to proceed under proper conditions in the presence of a suitable catalyst as described. Obviously combinations of these reactions may occur when conditions favor each of them. These reactions illustrate generally the type of reactions possible between aliphatic hydrocarbons of which, of course, there are numerous variations possible, as for example, when unsaturated hydrocarbons are used.

Reactions between aromatics and saturated aliphatics are exemplified below:

$$C_6H_6+C_nH_{2n+2}=C_6H_{6-y}(CH_3)y+C_{n-y}H_{2(n-y)+2}$$

where

$$x+y=6$$

and

$$n>y$$

For example:

$$C_6H_6+C_2H_6=C_6H_5CH_3+CH_4$$

and

$$C_6H_6+C_2H_6=C_6H_4(CH_3)_2+CH_4$$

Here again numerous variations and combinations are possible some of which result in the formation of multi-ring compounds and may be exemplified by the general reaction:

$$nC_6H_6R'+mC_6H_6R''=(C_6H_4)_{n+m}+R'_nR''_m$$

Reactions between paraffins and ammonia to form amines and H_2 are not favored thermodynamically but those forming amines and a paraffin hydrocarbon are favored and may be generally shown thus:

$$RR_1+NH_3=RNH_2+RH$$

Those between ammonia and olefines can be carried out successfully, particularly when the number of carbon atoms in the hydrocarbon is relatively small. The general reaction may be expressed as below:

$$C_nH_{2n}+NH_3=C_nH_{2n+1}NH_2$$

Similarly OH groups, NH_2, CO, CHO, halide, nitrogen, and sulphur groups and the like may be substituted in various hydrocarbons, their derivatives, and other organic compounds.

In general the catalysts employed in the operation of my invention are those generally classed as hydrogenating-dehydrogenating catalysts of which a great many are known such as for example, nickel, palladium, platinum, copper, iron, oxides of nickel, chromium, copper, zinc, and many other metals, their oxides, sulphides and other compounds thereof and mixtures of the same. It must not be inferred from this that the action of these various materials is identical and that any one of them may be used for any reaction. The extent to which they catalyze the various reactions differs markedly from one material to another and their specificity in the activation of certain bonds is also different. However, by selecting that catalyst which is found to activate the desired bonds under the proper conditions, these reactions may be caused to proceed in the direction of the desired products.

I claim:

1. The process of alkylating aromatic hydrocarbon compounds by paraffinic hydrocarbon compounds which comprises activating a bond external to the aromatic ring of an aromatic hydrocarbon compound by subjecting it to the action of a hydrogenating-dehydrogenating catalyst having specificity properties for said external bond, under such conditions of temperature and pressure that said catalyst specifically activates said external bond, simultaneously activating a carbon to carbon bond of a paraffinic hydrocarbon compound by the action of said catalyst in the presence of said activated aromatic hydrocarbon compound to form activated residues of said paraffinic hydrocarbon compound whereby said activated residues react with and alkylate said activated aromatic hydrocarbon compound.

2. The process of alkylating aromatic hydrocarbon compounds by paraffinic hydrocarbon compounds which comprises activating a bond external to the aromatic ring of an aromatic hydrocarbon compound by subjecting it to the action of a hydrogenating-dehydrogenating catalyst having specificity properties for said external bond, under such conditions of temperature and pressure that said catalyst specifically activates said external bond, simultaneously activating a bond of a paraffinic hydrocarbon compound by the action of said catalyst in the presence of said activated aromatic hydrocarbon compound to form activated residues of said paraffinic hydrocarbon compound whereby said activated residues react with and alkylate said activated aromatic hydrocarbon compound.

Plaintiff's Exhibit 10 (continued).

3. The process of alkylating aromatic hydrocarbon compounds by paraffinic hydrocarbon compounds which comprises activating bonds external to the aromatic ring of an aromatic hydrocarbon compound by subjecting it to the action of a hydrogenating-dehydrogenating catalyst having specificity properties for said external bond, under such conditions of temperature and pressure that said catalyst specifically activates said external bonds, simultaneously activating a carbon to carbon bond of a paraffinic hydrocarbon compound by the action of said catalyst in the presence of said activated aromatic hydrocarbon compound to form activated residues of said paraffinic hydrocarbon compound whereby said activated residues react with and alkylate said activated aromatic hydrocarbon compound.

4. The process of methylating aromatic hydrocarbon compounds which comprises subjecting ethane to the action of a hydrogenating-dehydrogenating catalyst under conditions such that said catalyst having specificity properties for the carbon to carbon bond of ethane, specifically activates the carbon to carbon bond of the ethane to form activated methyl groups, simultaneously subjecting an aromatic hydrocarbon compound to the action of said catalyst in the presence of the ethane, said catalyst and said conditions being also such that said catalyst specifically activates a bond external to the aromatic ring of said aromatic hydrocarbon compound, whereby said activated methyl groups react with and methylate said activated aromatic hydrocarbon compound.

5. The process of synthesizing alkylated benzenes which comprises subjecting benzene and saturated paraffin hydrocarbon of the general formula C_nH_{2n+2}, where n is 2 or greater, to the action of a hydrogenating-dehydrogenating catalyst at a temperature and for an interval of time sufficient to produce a substantial yield of alkylated benzene.

6. The process of synthesizing toluene from benzene and ethane which comprises subjecting ethane to the action of a hydrogenating-dehydrogenating catalyst having specificity properties for the carbon to carbon bond of ethane, under conditions of temperature and pressure such that said catalyst specifically activates the carbon to carbon bond of the ethane to form activated methyl groups, simultaneously subjecting benzene to the action of said catalyst in the presence of the ethane, said catalyst and said conditions being also such that said catalyst specifically activates a bond external to the aromatic ring of said benzene, whereby said activated methyl groups react with and methylate said activated benzene to form toluene.

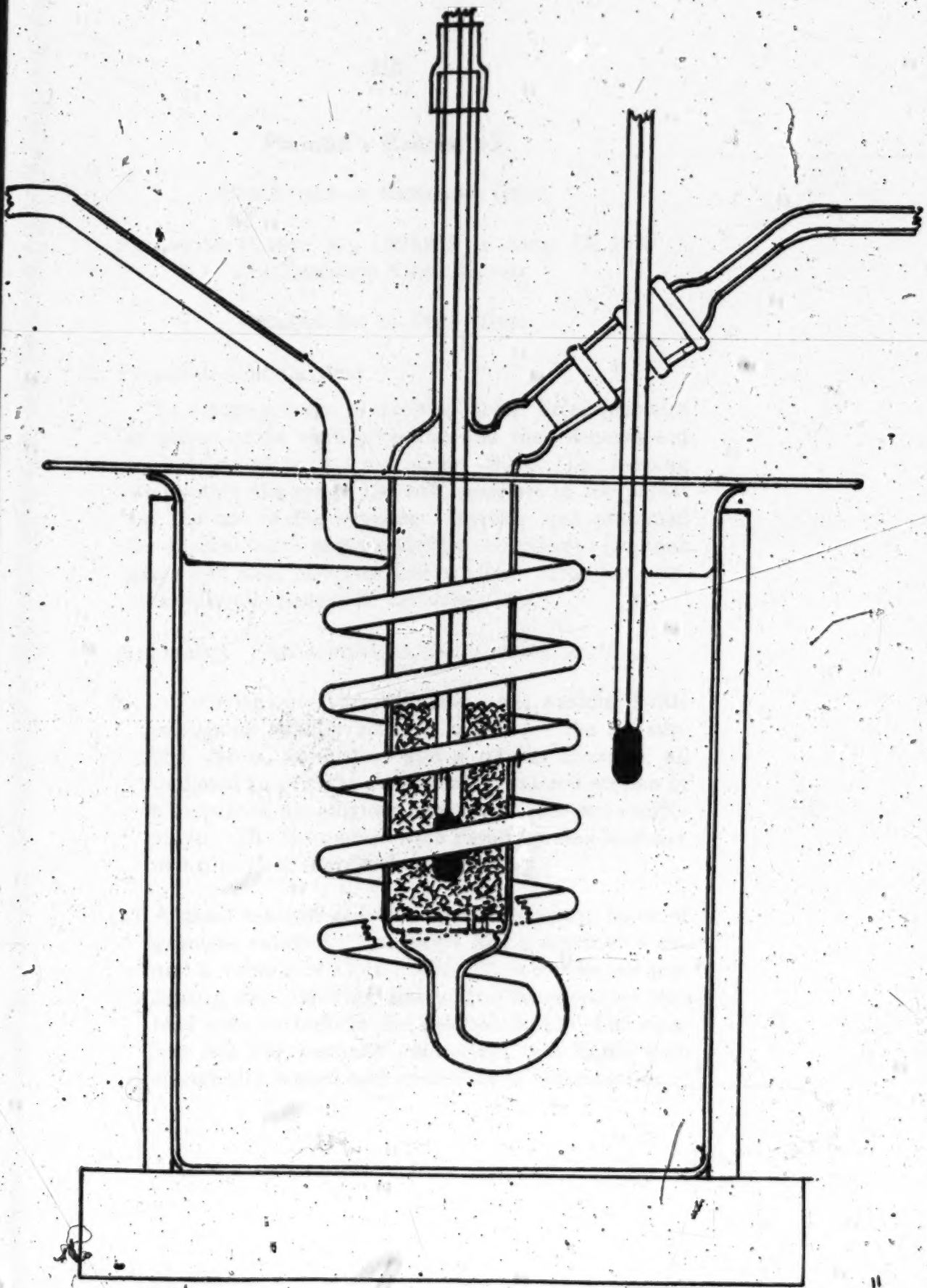
7. The process of synthesizing toluene from benzene and ethane which comprises subjecting ethane to the action of a hydrogenating-dehydrogenating catalyst having specificity properties for the carbon to carbon bond of ethane under conditions of temperature and pressure such that said catalyst specifically activates the carbon to carbon bond of the ethane to form activated methyl groups, simultaneously subjecting benzene to the action of said catalyst in the presence of the ethane, said catalyst and said conditions being also such that said catalyst specifically activates an external bond of said benzene, whereby said activated methyl groups react with and methylate said activated benzene to form toluene.

8. The process of synthesizing toluene from benzene and ethane which comprises subjecting ethane to the action of an active nickel catalyst under conditions such that said catalyst specifically activates the carbon to carbon bond of the ethane to form activated methyl groups, simultaneously subjecting benzene to the action of said catalyst in the presence of the ethane, said catalyst and said conditions being also such that said catalyst specifically activates an external bond of said benzene, whereby said activated methyl groups react with and methylate said activated benzene to form toluene.

9. The process of synthesizing toluene from benzene and ethane which comprises subjecting benzene and ethane to the action of an active nickel catalyst at a temperature ranging from 150° C. to 300° C. for a time interval sufficient to produce a substantial yield of toluene.

HUGH S. TAYLOR.

Plaintiff's Exhibit 11.



Plaintiff's Exhibit 12.

PRODUCTION OF ETHYLENE OXIDE

FOLLOWING PATENT No. 1,998,878 OF APRIL 23, 1935
TO THEODORE EMILE LEFORT

Catalyst No. 1—Pure Silver

1. Preparation of Catalyst

To secure a large surface of silver, dried granules of silver oxide were prepared and then decomposed by heating up to, but not above, 390°C. (i.e., keeping well within the range 150-400° specified in the patent for the use of the catalyst. Heating was continued for several hours until no further evolution of gas took place and until the dark brown silver oxide had substantially all changed to metallic silver.

2. Apparatus. This comprised the following parts:

(a) An ethylene pressure cylinder, a gas washing bottle containing slightly acidified water for the air supply, valves, flowmeters and a mixing chamber, all designed to provide a constant, regulated stream of a moistened air-ethylene mixture of constant composition. The flowmeters were carefully standardized, using air and ethylene, respectively.

(b) A glass catalyst cell to hold the columnar layer of granular catalyst. This layer had a depth of 4 cm. and a volume of 17 cc. The cell had coils for preheating the inflowing gas and a thermometer was held with its bulb in the catalyst layer. The catalyst cell was partially submerged in a liquid bath electrically heated and containing a thermometer.

Plaintiff's Exhibit 12 (continued).

(c) A train of Leidner wash bottles containing solutions which would absorb any ethylene oxide or carbon dioxide present in the gas issuing from the catalyst cell.

3. Procedure

Air was introduced at a rate of very nearly 500 cc. per minute; ethylene in most cases at 10 cc. but in one at 5 cc. per minute. This gave a mixture of approximately two (or one) per cent of ethylene in air which is just below the recognized lower explosive limit of such mixtures.

The temperature of the bath and the catalyst could be raised gradually by increasing the electric current in the heater under the bath. Convection currents in the bath liquid were rapid enough so that, with air alone flowing through the cell, there was only a slight differential between the reading of the thermometer in the catalyst and that in the bath. In the first run the solution for collecting and detecting the ethylene oxide was a hot, acidified, saturated salt solution containing methyl red as an indicator whose change in color showed the complete consumption of the hydrochloric acid by the ethylene oxide which dissolves. In later runs a saturated solution of sodium chloride containing a known amount of hydrochloric acid and also various indicators, was used to absorb the ethylene oxide. The carbon dioxide was partially collected by bubbling the gas issuing from the ethylene oxide absorbers through wash bottles containing known amounts of standardized sodium hydroxide solution. In some final runs a solution of nearly saturated magnesium chloride in water was used to collect the ethylene oxide as this gave a more complete absorption than the sodium chloride solution. In one of these runs the

Plaintiff's Exhibit 12 (continued).

carbon dioxide was also collected quantitatively by passing the gas mixture leaving the last ethylene oxide absorber through two Emmerling towers in series charged with concentrated sulphuric acid and then to two weighed U tubes filled with potassium hydroxide pellets.

To carry out a run, the controlled mixture of ethylene and air was passed through the catalyst at a given temperature until a steady state had been established as indicated by the readings of the thermometers. The effluent gas from the catalyst cell was then by means of a two-way stopcock made to pass through the absorbers, frequent readings of the flowmeters and the thermometers being made. After a suitable interval, as measured by a stopwatch, the flow through the absorbers was discontinued. The amount of ethylene oxide in the absorbers was then determined by titration. Similarly, the sodium hydroxide solution used for absorbing the carbon dioxide was titrated and the amount of carbon dioxide absorbed thus ascertained, or the U tubes were re-weighed.

4. Results

(a) In the first run, using a gas stream containing 500 cc. of air and 10 cc. of ethylene and slowly raising the temperature of the bath, a slight rise in the temperature of the catalyst as compared with that of the bath liquid was observed when the catalyst temperature reached 190°C., the differential increasing as the temperature rose. At the same time the warmed, saturated salt solution to which about ½ cm. of tenth molar hydrochloric acid and some methyl red had been added, through which the effluent gases bubbled, changed to a yellow color in about 3 minutes. Similar tests with repeated additions

Plaintiff's Exhibit 12 (continued).

of small amounts of tenth molar hydrochloric acid up to 6 cc. and with various indicators (methyl red, brom thymol blue and phenolphthalein) showed complete consumption of the acid by the ethylene oxide.

(b) In a second run the same mixture was passed through the catalyst at an average constant temperature of 213.5°±1 for 15 minutes and then through two wash bottles at room temperature containing an excess of the same absorbing solution. Analysis showed 28.7% conversion of the ethylene into ethylene oxide.

(c) In a third run an additional wash bottle containing a measured volume of standardized sodium hydroxide solution was attached to the end of the train to collect carbon dioxide in the effluent gas from the catalyst. To guard against any carbon dioxide in the inlet gas, a wash bottle containing sodium hydroxide solution was also introduced into the air supply ahead of the wash bottle containing dilute acid. Collecting the gas over a 15 minute interval, at an average catalyst temperature of 232°, 33.6% of the ethylene was converted to ethylene oxide and 6.3% to carbon dioxide. A repetition of this run at an average catalyst temperature of 235.5° gave a conversion of ethylene to ethylene oxide of 27.1% and to carbon dioxide of 6.1%.

(d) In subsequent runs, to guard against a possible slight loss of ethylene oxide from the second wash bottle, an additional (third) wash bottle was added containing an additional amount of the same absorbing solution. Several runs were made under otherwise identical conditions at catalyst temperatures of 215.5°, 229.0° and 244.7°. These gave an increased conversion both to ethylene oxide and to carbon dioxide as the temperature increased.

Plaintiff's Exhibit 12 (continued).

(e) A single run was made with a poorer mixture of ethylene, namely, 505 cc. of air and 5.05 cc. of ethylene per minute at a catalyst temperature of 218°. Conversions of 37.4% of the ethylene to ethylene oxide and 9.1% to carbon dioxide were obtained. These conversions were higher than would have been obtained at the same temperature in the richer gas (2% ethylene).

(f) Three runs were made using magnesium chloride solutions in the absorbers for the ethylene oxide, 515—520 cc. of air and 10.0 cc. of ethylene per minute at catalyst temperatures of 227.1, 227.5 and 230.3°C. Conversions of 34.1, 34.0 and 37.7% respectively of the ethylene to ethylene oxide were obtained.

In the final run the carbon dioxide was determined quantitatively and a conversion of 43.7% of the ethylene into carbon dioxide was obtained.

The data for the several runs are collected in the following table and the percentage conversions have been plotted in the accompanying diagram.

SPACE VELOCITY PER HOUR=1835±1%

No.	Flow cc./min. Air	Flow cc./min. C_2H_4	Temperature C° Catalyst	Temperature C° Bath	Bottles for C_2H_4O	Collection Interval min.	Conversion Vol. % C_2H_4O	Date
1	515	10.2	234	213.6	2	15	28.7	May 26
2	510	9.9$_5$	232	212.0	2	15	33.6	" 26
3	510	10.0$_0$	235.5	214.5	2	15	27.1	" 29
4	505	9.9$_5$	230.2	212.0	3	15	34.9	" 31
5	505	5.0$_5$	230.2	218.3	3	30	37.4	" 31
6	505	10.0$_5$	215.5	202.1	3	20	26.5	June 1
7	510	9.9$_5$	244.7	223.3	3	15	37.5	" 1
8	510	9.9$_5$	229.0	212.0	3	15	33.5	" 1
9	515	10.0$_0$	227.1	209.5	3	15	34.1	" 9
10	520	10.0$_0$	227.5	209.6	3	15	34.0	" 9
11	515	10.0$_0$	230.3	211.5	3	15	37.7	" 9

Plaintiff's Exhibit 12 (continued).

Catalyst No. 2—Silver on Earthenware

1. Preparation of Catalyst.

To secure, if possible, a large surface of silver from a relatively small weight of the metal, we impregnated 50 cc. of granular, unglazed earthenware by boiling it with a nearly saturated solution of silver nitrate for about an hour. After draining off the excess solution the material was dried overnight at 115°C. The dried granules were then heated until no more nitrate fumes were given off. This required prolonged heating overnight at temperatures of 440-463°C. Examined under the microscope the bright silver particles could be seen over the earthenware base, but the silver was more lustrous than that of Catalyst No. 1.

2. Apparatus and Procedure

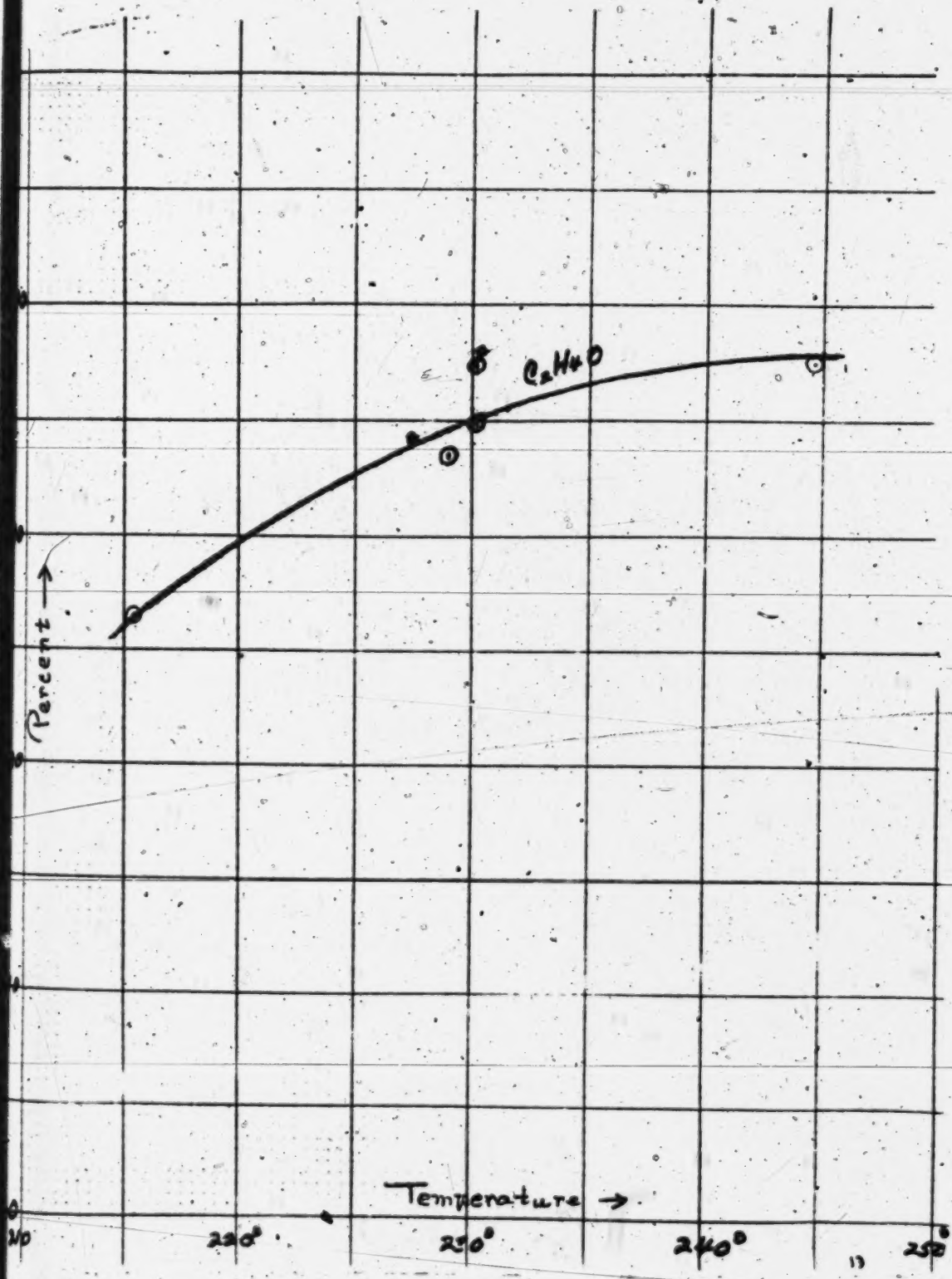
These were as before except that a final collection period of 30 minutes was employed.

3. Results

The catalyst temperature was slightly higher (3-4°) than the bath temperature at a temperature of 190°, but the differential increased but slightly as higher temperatures were reached (4-5° at 245°C.). The sample of effluent gas collected at this latter temperature (245°) on analysis showed only 0.9% conversion of ethylene to ethylene oxide and 0.24% to carbon dioxide.

June 3, 1940

Plaintiff's Exhibit 13.



Plaintiff's Exhibit 19.

AVERAGE DAILY WATER VAPOR CONTENT IN AIR CALCULATED AS PER CENT BY VOLUME FOR BALTIMORE, MARYLAND

APRIL 1st, 1939 — APRIL 30th, 1940

	1939									1940			
	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	0.95	0.53	1.775	1.995	2.28	2.04	1.455	0.715	0.70	0.18	0.34	0.56	0.615
2	0.52	0.53	1.265	1.65	2.425	2.235	1.035	0.565	1.015	0.22	0.345	0.56	0.535
3	0.45	0.54	1.425	1.575	2.665	2.265	1.05	0.56	0.645	0.18	0.31	0.76	0.81
4	0.33	0.60	1.605	2.385	2.34	2.295	1.27	0.525	0.555	0.235	0.36	0.69	1.11
5	0.48	0.80	1.21	2.345	1.795	1.65	1.415	0.82	0.535	0.215	0.515	0.585	0.565
6	1.05	1.13	1.48	2.31	1.875	1.45	1.81	0.63	0.70	0.24	0.645	0.48	0.495
7	0.36	1.47	1.23	2.71	2.25	2.11	1.63	0.685	0.72	0.23	0.575	0.44	0.77
8	0.47	1.61	1.94	2.94	2.665	2.355	1.685	0.67	0.40	0.355	0.445	0.49	1.20
9	0.46	2.02	2.08	2.615	2.815	2.03	2.17	0.535	0.50	0.215	0.55	0.45	0.845
10	0.78	1.03	2.04	2.29	1.575	2.16	2.04	0.675	0.73	0.245	0.715	0.335	0.70
11	1.24	0.89	2.415	1.29	1.95	1.26	1.37	0.55	0.54	0.335	0.65	0.255	0.88
12	0.47	0.55	1.48	1.715	2.20	1.315	1.24	0.565	0.32	0.575	0.59	0.22	0.96
13	0.35	0.71	1.875	2.055	2.625	1.625	0.925	0.52	0.56	0.635	0.66	0.315	0.31
14	0.51	0.77	1.735	2.115	2.815	1.625	0.715	0.585	0.49	0.89	0.60	0.825	0.485
15	1.01	0.78	1.88	1.23	2.80	1.885	0.535	0.535	0.39	0.405	0.24	0.495	1.165
16	0.69	0.89	2.505	1.135	2.70	2.26	0.755	0.635	0.53	0.435	0.24	0.45	1.165
17	0.80	1.19	2.60	1.69	2.625	1.655	0.73	0.715	0.65	0.23	0.395	0.53	1.235
18	1.24	1.30	1.495	1.945	2.725	0.985	0.53	0.86	0.72	0.205	0.575	0.695	1.325
19	1.10	1.475	1.91	1.92	2.645	1.41	1.135	1.01	0.66	0.125	0.795	0.66	0.975
20	0.68	1.80	2.39	1.915	2.695	1.775	1.43	0.475	0.87	0.165	0.675	0.74	0.95
21	0.94	1.69	1.485	1.755	2.57	1.585	1.445	0.495	0.38	0.22	0.35	0.28	0.75
22	0.73	2.095	1.715	1.74	1.705	1.29	1.135	0.565	0.35	0.27	0.335	0.445	0.505
23	0.66	2.17	1.945	2.105	2.13	1.70	0.605	0.575	0.31	0.275	0.345	0.16	0.615
24	0.90	1.08	1.555	2.54	2.47	1.72	0.805	0.51	0.21	0.325	0.455	0.16	0.705
25	1.17	1.35	1.635	2.52	2.36	2.045	1.05	0.485	0.31	0.24	0.375	0.165	0.885
26	1.70	1.77	1.465	2.66	2.175	1.745	1.61	0.27	0.43	0.125	0.18	0.295	0.665
27	1.54	2.17	1.91	2.71	1.955	1.695	1.825	0.355	0.32	0.155	0.43	0.56	0.565
28	0.99	2.24	2.02	2.655	1.905	1.725	1.22	0.53	0.25	0.18	0.55	0.655	0.64
29	0.84	1.935	2.495	2.42	1.77	2.185	0.57	0.48	0.49	0.23	0.445	0.895	0.85
30	0.63	1.93	2.54	2.66	1.785	2.27	0.885	0.665	0.36	0.265		1.295	1.11
31		1.79		2.265	1.92		1.065		0.32	0.285		1.005	
Mo. Ave.	0.80	1.317	1.837	2.124	2.297	1.802	1.198	0.592	0.515	0.278	0.473	0.528	0.799
Cumul. Mo. Ave.	0.80	1.06	1.186	1.5195	1.675	1.696	1.625	1.496	1.387	1.276	1.203	1.147	1.12
Yearly Ave.													

	Reissue No. 20,370		No. 1,998,878	
	Application September 25, 1936	Issued May 18, 1937	Application March 22, 1932	Issued April 23, 1935

LEFORT ORIGINATED A PROCESS IN WHICH ETHYLENE OXIDE IS OBTAINED DIRECTLY FROM ETHYLENE AND MOLECULAR OXYGEN BY THE DIRECT ADDITION OF ONE ATOM OF OXYGEN TO ONE MOLECULE OF ETHYLENE.

P. 1, col. 1, lines 1-4
"This invention provides a specific and novel process for making ethylene oxide. It essentially consists in causing ethylene to combine directly with molecular oxygen . . ."

P. 1, col. 1, lines 12-14
"This process is characterized by an entirely unique reaction in which the direct addition of a single oxygen atom to the ethylene molecule. . ."

P. 1, col. 1, lines 17-20
"This novel reaction may be expressed as:

$$2CH_2{=}CH_2 + O_2 \longrightarrow 2CH_2{-}CH_2"$$
(O)

P. 1, col. 1, lines 1-2
"This invention has for object a process for the production of ethylene oxide . . ."

P. 1, col. 1, lines 9-14
". . . the reaction which can be written as follows:

$$2\ \begin{matrix}H_2C\\ \|\\ H_2C\end{matrix} + O^2 \longrightarrow 2\ \begin{matrix}H_2C\\ \diagdown O \diagup\\ H_2C\end{matrix}"$$

LEFORT DISCOVERED THAT ETHYLENE OXIDE IS THUS PRODUCED BY SUBJECTING A MIXTURE CONTAINING ETHYLENE AND MOLECULAR OXYGEN TO HIS COMBINATION OF SILVER SURFACE CATALYST AND CONTROLLED TEMPERATURE BETWEEN 150° AND 400° C., WITH WATER ALWAYS PRESENT IN THE REACTION ZONE.

P. 1, col. 1, lines 2-8
"It essentially consists in causing ethylene to combine directly with molecular oxygen at temperatures of about 150° to about 400° C. in the presence of a surface catalyst which favors the oxidation of ethylene to ethylene oxide under these conditions."

P. 1, col. 1, lines 26-36
"Ethylene from any desired source may be used, including that obtained from coke oven gas, hydrogenation of acetylene, or dehydration of ethyl alcohol. The oxygen can be the oxygen of the air, and can conveniently be mixed with the ethylene prior to the reaction.
"The oxidation of ethylene takes place with a giving off of heat, and it is, of course, desirable to maintain the temperature of the zone of reaction within the range specified."

P. 1, col. 1, lines 43-54
"The process can be conveniently conducted by passing a mixture containing air and ethylene through a tube, for example, of silica or of a material capable of withstanding high pressures, within which is placed such a surface catalyst as one composed of silver in finely divided form, and which may be disposed within the tube on a supporting material, or in other known ways. The temperature of the reaction zone is maintained between about 150° and about 400° C., for example, at about 200° C., and the issuing products from the tube contain ethylene oxide, . . ."

P. 1, col. 2, lines 12-17
"In any case, the ethylene and oxygen are thus reacted simultaneously at the temperatures set forth in the presence of a surface catalyst and of water, and the process is conducted to produce ethylene oxide as a direct product in substantial and economic amount."

P. 1, col. 1, lines 1-6
"This invention has for object a process for the production of ethylene oxide which mainly consists in subjecting ethylene to the simultaneous action of the oxygen of air and of water, in presence of a catalyzer and, if need be, of hydrogen."

P. 1, col. 1, lines 16 and 20-21
"This reaction takes place . . . at a temperature between 150 and 400° C."

P. 1, col. 1, lines 22 and 26
"The following catalyzers may be used:
"(2) Silver alone."

P. 1, col. 2, lines 6-9
"The ethylene can be obtained from any source of supply: gas from coke ovens, hydrogenation of acetylene, dehydration of ethyl alcohol, and the like."

P. 1, col. 2, lines 12-13
"The oxygen can be the oxygen of the air, this latter gas being introduced in the reaction."

P. 2, col. 1, lines 28-33
"Silver in powder form, or in the form of a wire gauze, and placed or not on a support or carrier, is introduced in a tube, made for instance of silica, and, after the said tube has been heated to a temperature comprised between 150 and 400° C. . . ."

IN LEFORT'S PROCESS, THE ETHYLENE OXIDE IS PRODUCED WITHOUT SUBSTANTIAL FORMATION OF ALDEHYDES BUT WITH BURNING OF SOME ETHYLENE TO WATER AND CARBON DIOXIDE.

P. 1, col. 1, lines 15-25
". . . without the formation of significant amounts of other oxygenated compounds such as aldehydes. This novel reaction may be expressed as:

$$2CH_2{=}CH_2 + O_2 \longrightarrow 2CH_2{-}CH_2$$
O

and it is accompanied by complete oxidation of some of the ethylene to give carbon dioxide and water according to the equation:

$$CH_2{=}CH_2 + 3O_2 \longrightarrow 2CO_2 + 2H_2O"$$

P. 1, col. 1, lines 53-55
". . . the issuing products from the tube contain ethylene oxide, carbon dioxide and water without objectionable aldehydes."

P. 1, col. 2, lines 14-18
"The efficiency of the reaction is increased by diminishing the CO_2 which is formed, by introduction, in this reaction, of a suitable quantity of water. A suitable volume of CO_2 can also be previously introduced in the reacting gases."

P. 1, col. 2, lines 29-35
"Aldehydes formed exist only as traces.
"Moreover, the applicant has found that the reaction giving CO_2 is, contrarily to previous belief, a reaction of oxidation independent from that giving ethylene oxide and from that giving aldehydes."

P. 1, col. 2, line 41

$$"C_2H_4 + 3O_2 = 2H_2O + 2CO_2"$$

French Patent No. 739,562

Demandé le 3 octobre 1931 — Délivré le 3 novembre 1932

P. 1, lines 1-2
"La présente invention a pour objet un procédé d'obtention de l'oxyde d'éthylène . . ."

P. 1, lines 8-11
". . . des réactions de base du procédé qui peuvent être exprimées sous la forme suivante:

P. 1, lines 1-6
"La présente invention a pour objet un procédé d'obtention de l'oxyde d'éthylène qui consiste principalment à soumetre l'éthylène à l'action simultanée de l'oxygène de l'air et de l'eau en présence d'un catalyseur et d'hydrogène."

P. 1, lines 12, 16-17
"Cette réaction . . . à une température comprise entre 150 et 400° C."

P. 1, lines 18-19, 23
"Les catalyseurs employés peuvent être les suivants:
"2° L'argent seul;"

P. 1, lines 46-49
"L'éthylène peut provenir de n'importe quelle source: gaz des fours à coke, hydrogénation de l'acétylène, déshydratation de l'alcool éthylique, et autres."

P. 2, lines 4-5
"L'oxygène peut être l'oxygène de l'air, ce dernier gaz étant introduit dans la réaction."

P. 2, lines 32-37
"Dans un tube, par exemple en silice, on introduit de l'argent en poudre, ou sous forme de toile, sur un support ou non et, après avoir porté le tube à une température comprise entre 150 et 400°. . . ."

1st Addition—No. 41,811

Demandée le 19 décembre 1931 — Délivrée le 21 janvier 1933

P. 1, lines 5-8
". . . consiste principalement à soummettre l'éthylène à l'action simultanée de l'oxygène et de l'eau en présence d'un catalyseur . . ."

P. 1, lines 11-16
". . . la réaction a lieu . . . en présence de catalyseurs parmi lesquels est cité l'argent sous forme colloïdale, sous forme de poudre ou de toile."

P. 1, lines 28-33
"c. On augmente le rendement de la réaction en diminuant le CO^2 qui se forme, par l'introduction, dans cette réaction, d'une quantité d'eau convenable et en mélangeant au préalable, aux gaz réagissants, un volume convenable de CO^2;"

P. 2, lines 2-3
"Les aldéhydes formées ne le sont qu'à l'état de traces."

P. 2, lines 11-16
"De plus, on a constaté que la réaction donnant le CO^2 est, contrairement à ce que l'on a cru jusqu'à ce jour, une réaction d'oxydation indépendante de celle qui donne l'oxyde d'éthylène et de celle qui donne les aldéhydes."

P. 2, line 24

"$C_2H_4 + 3O_2 = 2\ H_2O + 2\ CO_2$"

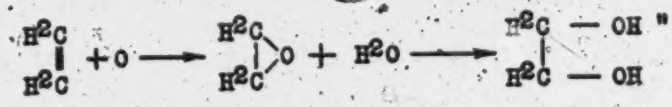
French Patent No. 729,952

Demandé le 27 mars 1931 — Délivré le 3 mai 1932

P. 1, lines 3-11

". . . à soumettre l'éthylène provenant de n'importe quelle source: gaz des fours à coke, hydrogénation de l'acétylène, déshydratation de l'alcool éthylique, etc., à l'action simultanée de l'oxygène de l'air et de l'eau.

"La réaction étant à la base de ce procédé peut être envisagée de la façon suivante:



"

P. 1, lines 45-47

"1° Procédé d'obtention de l'éthylèneglycol par action simultanée de l'oxygène de l'air et de l'eau sur l'éthylène; . . ."

2nd Addition—No. 41,474

Demandée le 10 septembre 1931 — Délivrée le 25 octobre 1932

P. 1, lines 11-22

"La présente addition a pour but de préciser que l'obtention du glycol qu'on obtient à partir de l'oxydation de l'éthylène par l'oxygène de l'air, en présence d'eau, provient nécessairement de la saponification de l'oxyde d'éthylène obtenu en première phase par oxydation directe de l'éthylène. Le mécanisme, indiqué dans le brevet principal et la première addition relative à celui-ci, tend donc à produire au préalable l'oxyde d'éthylène qui, par saponification directe, donne le glycol."

French Patent No. 729,952

P. 1, lines 6-7

". . . à l'action simultanée de l'oxygène de l'air et de l'eau."

P. 1, lines 31-34

"Ces deux gaz seront dirigés dans un tube de réaction . . . contenant un des catalyseurs indiqués ci-dessus, . . ."

P. 1, lines 52-53

"3° La température de réaction est maintenue de préférence entre 150 et 300° C.;"

2nd Addition—No. 41,474

P. 1, lines 33-38

"Dans un tube, par exemple en silice, on introduit de l'argent en poudre, ou sous forme de toile, sur un support ou non et, après avoir porté le tube à une température comprise entre 250 et 400°, . . ."

P. 2, lines 17-23

"2° Obtention d'oxyde d'éthylène par oxydation directe de l'éthylène par l'oxygène de l'air en présence de vapeur d'eau et en contact des catalyseurs cités dans le brevet et la première addition, notamment l'argent et ses mélanges avec le bismuth, l'antimoine, le plomb, l'étain, le nickel."

French Patent No. 729,952

P. 2, lines 5-7

"5° En évitant d'ajouter de l'eau à la réaction on peut obtenir uniquement de l'oxyde d'éthylène."

4th Addition—No. 41,810

Demandée le 19 décembre 1931 — Délivrée le 21 janvier 1933

P. 1, lines 27-32

"c. On augmente le rendement de la réaction en diminuant le CO_2 qui se forme, par l'introduction, dans cette réaction, d'une quantité d'eau convenable et en mélangeant au préalable, aux gaz réagissants, un volume convenable de CO_2;"

P. 1, lines 45-46

"Les aldéhydes formées ne le sont qu'à l'état de traces."

P. 2, lines 8-13

"De plus, on a constaté que la réaction donnant le CO_2 est, contrairement à ce que l'on a cru jusqu'à ce jour, une réaction d'oxydation indépendante de celle qui donne l'oxyde d'éthylène et de celle qui donne les aldéhydes."

P. 2, line 21

"$C_2H_4 + 3O_2 = 2\ H_2O + 2\ CO_2$"

Plaintiff's Exhibit 21.

DISTRICT COURT OF THE UNITED STATES

FOR THE DISTRICT OF MARYLAND

CARBIDE AND CARBON CHEMICALS CORPORATION, Plaintiff, vs. U. S. INDUSTRIAL CHEMICALS, INC., Defendant.	Civil Action File No. 249

Plaintiff's Statement Regarding its Operations Under Lefort Reissue Patent No. 20,370

In its manufacturing plant at South Charleston, West Virginia, plaintiff is now and has continuously since November, 1937, engaged in the commercial production of ethylene oxide by direct catalytic oxidation of ethylene with molecular oxygen. In doing so, plaintiff employs a chamber containing a catalyst essentially composed of silver disposed on an inert carrier. A gaseous mixture containing ethylene and the constituents of atmospheric air is passed continuously and substantially uniformly for extended periods of time through this chamber in intimate contact with said catalyst.

The gaseous mixture enters the chamber under superatmospheric pressure and it is saturated with water vapor at the working pressure and at approximately atmospheric temperature.

Plaintiff's Exhibit 21 (continued).

Throughout the operation the temperature within the said chamber is maintained substantially constant at a temperature between 150° and 400° C.

The ethylene and oxygen in the gaseous mixture react within the chamber, in the presence of the catalyst and of water, to produce ethylene oxide in substantial amount; and the resultant gaseous mixture, containing the said oxide and no substantial amounts of aldehydes, passes out of the said chamber continuously during the operation. The said resultant gaseous mixture contains usually about 1.5 per cent to about 2.0 per cent by volume of water vapor in addition to that contained in the entering gas mixture.

Thereafter, the ethylene oxide is dissolved out of the said resultant gaseous mixture and recovered in liquid form.

L. A. WATSON
Counsel for Plaintiff

Dated: May 21, 1940.

Plaintiff's Exhibit 22.

Munson Deposition Exhibit 8 for Identification
May 3, 1940
Stanley J. Cohara, Notary Public

THE DISTILLERS CO. LTD.

TELEPHONE WHITEHALL 1040.
(9 LINES)

TELEGRAMS -
"FERMENTER, LESQUARE, LONDON"

KINNAIRD HOUSE,
2, PALL MALL EAST,
LONDON, S.W.1. December 6th 1935.

C.E. Adams Esq.,
Air Reduction Company
Lincoln Building,
42nd Street,
NEW YORK.

Dear Adams

Many thanks for your letter of November 26th enclosing your Report on Research on Alcohol etc. for the period July 1 to October 1 of this year.

I send you herewith our Research Report for the period April 1st to December 1st 1935, direct as arranged and shall be very glad to answer any question you may have to ask in connexion with it.

With kind regards,
Yours sincerely,

Thos Ansard

Plaintiff's Exhibit 22 (continued).

3.

Work on the actual hydration of ethylene and propylene has been brought to a close on the small plant which has been in constant operation for two years. Sufficient information has been obtained regarding the activity of the solid catalysts employed, their active life and their mechanical stability. When this plant was dismantled recently, no corrosion of any part of the plant could be found.

Ethylene oxide.

Some time ago this company became interested in a French catalytic process for the manufacture of ethylene oxide from ethylene. The work at the time had not proceeded far but the process and methods leading up to industrial production have since been developed in these laboratories. Using air with 5% ethylene and working at ordinary atmospheric pressure and at temperatures of 300° to 350°C, a conversion of ethylene as high as 50% has been obtained, with an efficiency figure of 50 and a conversion figure of 50, (by which is meant that half the ethylene present is utilised per passage, half going to carbon dioxide and half going to ethylene oxide.) At present a unit comprising 10 catalytic tubes is being operated experimentally, and designs are being prepared for a larger unit which is expected to yield about 1 ton of ethylene per week. Work is in progress on the separation of the ethylene oxide from the resultant gaseous mixture of carbon dioxide and ethylene oxide and means of condensing olefine oxides and organic hydroxy compounds are being worked out, using as catalysts, for example, tertiary aliphatic amines. The conditions employed are for example 60-100°C and say 5-10 atmospheres pressure, under which conditions the condensation seems to proceed satisfactorily.

Lacquers.

The preparation of brushing lacquers is being studied, using nitrocellulose, water and solvents (a) where the water is the continuous phase, and (b) where the solvent is the continuous phase. With the former kind the results have not proved satisfactory, as the film, although continuous,

Plaintiff's Exhibit 22 (continued).

RADIOGRAM

Mackay Radio

ADDRESS: 67 Broad Street, New York

December 11, 1935

Board
Fermenter
Lesquare
London

PARTICULARLY ANXIOUS TO GET YOUR FULL DATA AT EARLIEST POSSIBLE DATE RE ETHYLENE OXIDE ABOUT WHICH EYRE SPOKE TO METZGER.

ADAMS

AIR REDUCTION SALES CO.

TO SEND A MESSAGE TELEPHONE WHITEHALL 4-6789 OR ANY POSTAL TELEGRAPH OFFICE. FOR OTHER PURPOSES — TELEPHONE BOWLING GREEN 9-3890. FOR MESSENGER TELEPHONE POSTAL TELEGRAPH OR RING POSTAL CALL BOX.

Plaintiff's Exhibit 22 (continued).

RCA

RADIOGRAM

RCA COMMUNICATIONS INC

RECEIVED AT ... NEW YORK, AT ... 9 26 ... STANDARD T

LX34 XUX GB2717

LONDON 43 13 1221

ADAMS DENATURED

NEWYORK

YOUR CABLE RECEIVED STOP FURTHER INFORMATION CONTAINED IN RESEARCH REPORT POSTED DECEMBER SIXTH STOP WE HAVE BRITISH EMPIRE RIGHTS ONLY STOP YOU SHOULD NEGOTIATE DIRECT WITH SOCIETE FRANCAISE DE CATALYSE GENERALISE 26 RUE PIERRE L HONNE COURBEVOIE SEINE FRANCE

BOARD

TELEPHONE HAnover 2-1811 To secure prompt action on inquiries, this original RADIOGRAM should be presented at the office R. C. A. COMMUNICATIONS, Inc. In telephone inquiries quote the number preceding the place of o

Plaintiff's Exhibit 22 (continued).

December 17, 1935

Mr Thomas H Board
The Distillers Co Ltd
Kinnaird House
2, Pall Mall East
London, S W 1
England

Dear Board

Thank you so much for your wire of December 13, and for your letter of December 6, enclosing your report on Research on Alcohol, for the period July 1 to October 1 of this year.

I have gone over this report with Metzger, and he has written me a memorandum, copy of which is enclosed. Any further information you can give us, as indicated by this memorandum, would be greatly appreciated.

With best regards,

Sincerely yours,

President

CEA:MMC

Enclosure

22/5

Plaintiff's Exhibit 22 (continued).

INTERIOR LETTERHEAD

DELIVER THIS LETTER TO	ADDRESS REPLY TO
Mr. C E Adams	Mr. F J Metzger
At	At

Date Dec 17,1935

SUBJECT:- PROGRESS REPORT FROM THE RESEARCH AND DEVELOPMENT DEPARTMENT OF THE DISTILLERS COMPANY,LIMITED April 1, 1935 to December 1, 1935

Replying to your letter dated

We have all been very much interested in this report.

Oil Cracking

Their experiences with oil cracking are substantially in line with our own. However, we have an advantage in our experimental work in that we can secure definite types of oils and thereby control our products to better advantage.

Cellulose Triacetate

We shall be glad to receive from time to time further information on their cellulose triacetate by the Berl process, particularly any developments in finding new solvents and plasticizers for this product.

Ethylene Oxide

We are of course interested in their work on ethylene oxide. The report is a little bit ambiguous and subject to more than one interpretation. For instance, it is not quite clear whether 1 1/4 or 2 1/2% of the 5% ethylene entering the reaction chamber is converted into ethylene oxide.

We also would be very glad to get more information on this subject, such as details of furnace construction, method of preparing the catalyst and mode of operation of the unit, whenever such information is available.

F J Metzger

FJM:IH

Plaintiff's Exhibit 22 (continued).

COPY.

THE DISTILLERS COMPANY LIMITED.

Research Department.

14th January 1936.

T.H. Board Esq.,
The Distillers Co. Ltd.,
etc.

Dear Mr. Board, Ethylene Oxide.

I see from Dr. Metzger's memorandum dated 17th December that he has not found very clear the figures which I gave in my report dated 6.12.35. under the heading of "Ethylene Oxide".

It is a little difficult to put briefly into words, but in amplification I may say that my meaning was that when using a 5% concentration of ethylene, half of the ethylene per passage remains unchanged, the other half being converted to an equal extent into ethylene oxide and carbon dioxide. This means that one quarter of the 5% original ethylene is used up in the formation of ethylene oxide and a quarter appears as carbon dioxide.

Since then, however, by modifying the apparatus, improved yields have been obtained and our present results may be stated as follows: Using an air mixture containing 5% ethylene, we are getting 75% of the ethylene utilised per passage, 45-50% of such ethylene utilised going to the formation of ethylene oxide, which means that 35-37% of the ethylene used appears as ethylene oxide per passage. This does not, however, represent the best results we have obtained, but they are figures upon which we fell we can rely. Our best figures have been 85% utilisation of ethylene and 55% of ethylene utilised going to produce ethylene oxide. I may say that the reaction gives a remarkably clean product. Only by chemical means can one detect by-products such as acetaldehyde, acids and per-compounds, presumably per-acetic acid. These improved results have justified modifying the design of the small plant which was being arranged for, but I hope that before long we shall be in a position to produce ethylene oxide regularly on a small scale.

With .....

Plaintiff's Exhibit 22 (continued).

With regard to details of plant and catalyst, I do not think we are free to communicate these to other parties for the following reasons: (1) We are working the problem out in conjunction with the Société Française de Catalyse Généralisée; (2) we are only interested in British Empire rights, and (3) although we are under an obligation to exchange with the S.F.C.G. all details of catalyst preparation and plant construction, the French firm will have to negotiate foreign rights.

I am returning the letter and memorandum as promised.

Yours truly,

(sd) J. Vargas Eyre.

Plaintiff's Exhibit 22 (continued).

HE DISTILLERS CO LTD.

TELEPHONE-WHITEHALL 1040
(8 LINES)

TELEGRAMS -
"FERMENTER, LESQUARE, LONDON"

KINNAIRD HOUSE,
2, PALL MALL EAST,
LONDON, S.W.1. January 17th, 1936.

C.E. Adams Esq.,
Air Reduction Company,
Lincoln Building,
42nd Street,
NEW YORK CITY. U.S.A.

Dear Adams,

I am sorry to have been so long in sending you an answer to your letter of December 17th, but I have been very busy.

I have discussed the Progress Report with Dr. Eyre particularly regarding Ethylene Oxide, and I enclose herewith copy of his reply.

With reference to Cellulose Triacetate, I would like to draw your attention to the fact that we put you in direct touch with Dr. Berl for his Cellulose Triacetate Process. We have the British rights only, but you can get full information from Dr. Berl on the Process and the Solvents and Plasticisers required. At the moment our small commercial experimental plant is in course of erection and is not likely to be working for a couple of months yet.

Yours sincerely,

Thos H Board

Dr Berl's address is the Carnegie Institute Pittsburgh University.

My people are very interested in synthetic propionic acid - have you any information on the subject

22/a

Plaintiff's Exhibit 22 (continued).

January 29th
1936

Thomas H. Board, Esq.
The Distillers Co. Ltd
Kinnaird House
2, Pall Mall East
London, S.W. 1
England

Dear Mr. Board:

Due to Carl Adams being in Florida, your letter of January 17th regarding Ethylene Oxide has been turned over to me.

Your experiments look very interesting. In case we should deem it advisable to get in touch with the Societe Francaise de Catalyse Generalisee about this situation, I would like your advice as to how this had better be done; would it be best to start this through you, approach them direct, or have they representatives in the U.S.A.? We would appreciate any help you can give us on this and will write you later in reference to it.

Regarding synthetic proprionic acid, we have no direct information about this in our own Research end, but I believe DuPont is making this from normal Propyl which they obtain as a by-product in their Methyl Alcohol Synthesis.

With all best wishes, I am

Faithfully yours,

CSM/ed

Plaintiff's Exhibit 22 (continued).

THE DISTILLERS CO. LTD.

TELEPHONE: WHITEHALL 1040 (6 LINES)

TELEGRAMS: "FERMENTER, LESQUARE, LONDON"

KINNAIRD HOUSE,
2, PALL MALL EAST,
LONDON, S.W.1.

10th February 1936

C.S. Munson, Esq.,
U.S. Industrial Alcohol Co.,
60, East 42nd Street,
NEW YORK.

Dear Munson,

Ethylene Oxide

In reply to your letter of the 29th January re ethylene oxide, the Societe Francaise de Catalyse Generalisee have no agent in the States and so I would write to them direct (at 26, Rue Pierre l'homme, Courbevoie, Seine) and not through us. I know they are in treaty with other people in America for the sale of their rights, but I do not believe anything has been completed.

I am much obliged for what you say about synthetic propionic acid, which I will take up with Dr. Eyre.

With kind regard,

Yours sincerely,

Howard

22/11

Plaintiff's Exhibit 22 (continued).

February 26th, 1936

Mr. Eugene W. Stetson
The Guaranty Trust Co.
140 Broadway
New York City

Dear Gene:

I am enclosing a letter addressed to the Societe Francaise de Catalyse Generalisee, who have a process for making Ethylene Oxide, which is turned into Ethylene Glycol (the basis of Prestone). From our various discussions, you know why we are interested in this process.

This information has come to us through the Distillers Co. Ltd. of England, who suggest we approach the French Company direct; as we are approaching them "cold" we felt it would be better to have it go through the Guaranty Trust, if such a procedure is agreeable to you. We are doing it in this way as we understand the French Company are negotiating with other people in the United States covering this process. If you would not mind asking your Paris Branch to handle this, it would be much appreciated by us.

Faithfully yours,

CSM/cd

Plaintiff's Exhibit 22 (continued).

Munson Deposition Exhibit 1 for Identification
May 3, 1940
Stanley J. Cohara, Notary Public.

February 26th
1936

Societe Francaise de Catalyse Generalisee
26, Rue Pierre L'homme
Courbevoie
Seine

Dear Sirs:

Our good friends the Distillers Co. Ltd. of England have suggested to us that you have a process for the making of Ethylene Oxide which might be of interest to this Company. We would be interested in such a process and would be glad to discuss this with you.

I am sending this letter to you through our good friends The Guaranty Trust Company, who will give you information about our Company and to whom we would be glad to have you give any information that you care to in reference to this process and in reference to any interest you might have in developing this in the United States.

Faithfully yours,

C. S. MUNSON
President

Plaintiff's Exhibit 22 (continued).

Guaranty Trust Company of New York

A merger of
National Bank of Commerce in New York - Guaranty Trust Company of New York
Organized 1839 Organized 1864

140 Broadway

Capital $90,000,000 Surplus $170,000,000.

Member of Federal Reserve System

New York Offices
140 Broadway
Cable Address: Guaranty
Fifth Avenue at 44th St
Cable Address: Saxonia
Madison Avenue at 60th St
Cable Address: Guarmadi

Foreign Department
Kent G. Colwell
Assistant Manager

Foreign Offices
Cable Address: Guaranty
London
Liverpool
Brussels
Paris
Havre
Antwerp

New York February 26, 1936.

CY

In replying please refer to
504-20

Mr. C. S. Munson, President,
U. S. Industrial Alcohol Co.,
60 East 42nd Street,
New York, N.Y.

Dear Mr. Munson:-

Mr. Stetson, who is leaving town tomorrow, has asked me to forward the letter addressed to the Societe Francaise de Catalyse Generalisee, which was enclosed in your letter to him of today's date.

Your enclosure has been sent to our Paris Office with a covering letter mentioning our close and important relations with your good company, which we request them to mention when delivering your letter to the Societe Francaise de Catalyse Generalisee.

It is a pleasure for us to be of service in this way and, if there is anything further in this connection that you would like to have us do, it will be a privilege for me to follow the matter on your behalf.

Yours very truly,

K. Colwell

Assistant Manager.

Plaintiff's Exhibit 22 (continued).

February 28th
1936

Mr. Kent G. Colwell,
Assistant Manager,
Foreign Department
Guaranty Trust Co. of New York
140 Broadway
New York City

Dear Mr. Colwell:

Many thanks for your very kind letter of February 26th and for your kindness in forwarding the letter to the Societe Francaise de Catalyse Generalisee through your Paris office.

Faithfully yours,

C. S. Munson
President.

CSM/cd

Cross Reference in Guaranty Trust Co file
See also Miscellaneous "C" file for correspondence with Societe Francaise de Catalyse Generalisee

2416

Plaintiff's Exhibit 22 (continued).

Guaranty Trust Company of New York

A merger of

National Bank of Commerce in New York - Guaranty Trust Company of New York

Organized 1839 Organized 1864

140 Broadway

Capital $90,000,000. Surplus $170,000,000.

Member of Federal Reserve System

New York Offices
140 Broadway
Cable Address "Fidelitas"
Fifth Avenue at 44th St.
Cable Address "Naissance"
Lexington Avenue at 60th St.
Cable Address "Guarantee"

Foreign Department
Kent G. Colwell
Assistant Manager

Foreign Offices
Cable Address "Satitas"
London Paris
Liverpool Havre
Brussels Antwerp

New York March 23, 1936.

In replying please refer to
504-20

Mr. C. S. Munson, President,
U. S. Industrial Alcohol Co.,
60 East 42nd Street,
New York, N.Y.

Dear Mr. Munson:-

With reference to our telephone conversation this afternoon, a copy of letter from our Paris Office and of the memorandum enclosed with it are herewith enclosed, in connection with your letter to the Ste. Francaise de Catalyse Generalisee delivered by our Paris Office.

Let us urge you once more to make use of us in any way possible if you feel that we can render any additional service in this matter.

Very sincerely yours,

K G Colwell

Assistant Manager.

Enclosure.

Plaintiff's Exhibit 22 (continued).

GUARANTY TRUST COMPANY OF NEW YORK

Paris Office

Letter to HEAL office Foreign Department,

Attention of: Mr. Kent G. Colwell, Assistant Manager.

PARIS 11th, March 1936.

U. S. Industrial Alcohol Co.
Ste. Franç. de Catalyse Generalisee

Dear Kent,

Upon receipt of your letter of Feb. 27th, enclosing a copy of the letter from President Munson of the United States Industrial Alcohol Co. to the Ste. Francaise de Catalyse Generalisee, we had the delivery made by Mr. d'Algay, with whose capacity and personality you are doubtless familiar. From the attached report you will see that the Managing Director of the Societe Francaise de Catalyse Generalisee is replying direct to the United States Industrial Alcohol Co. Needless to say, Mr. d'Algay went fully posted as to the standing of the United States Industrial Alcohol Co. and our relationship with them.

With kind regards,

Yours sincerely,

(Signed) ELLIOTT H. LEE
Vice President

EHL/CPG Encl.

Munson Deposition Exhibit 2 for Identification
May 3, 1940
Stanley J. Cohara, Notary Public

22/17

Plaintiff's Exhibit 22 (continued).

March 11, 1936.

U.S. INDUSTRIAL ALCOHOL COMPANY

Call on Mr. Francon, Managing Director of
SOCIETE FRANCAISE LE CATALYSE GENERALISEE

Mr. F. knows the U.S. Industrial Alcohol Company and Distillers Company Ltd., of England, the latter being the licencee of his process for the manufacture of ethylene oxide.

Mr. F. is very much interested in selling the licence for his process particularly in the United States which, in his opinion, represent several times the possibilities of production of all the rest of the world. He points out, however, that this transaction requires careful consideration on his part because he wants to make the most of this licence and will sell it only to the Companies which are best qualified to commercially give it the greatest development in the United States. This involves technicalities which can only be discussed with persons conversant with chemistry. He suggests, therefore, that the subject Company should send somebody to see him on the matter thinking that said Company may have some technical representative in Europe.

He has been investigating the matter in respect to possibilities in the United States for over one year and has been approached by four important Companies connected with producers of ethylene gas (cokeries petroleum refining). He considers himself now as well posted up in respect to United States possibilities and now anxious to bring the matter to a conclusion within the three or four next months.

In Europe, he has sold the licence in several important countries (England, Belgium, Italy) and quite recently to the U.R.S.S. He has also been approached by Germany which wanted to buy the licence for all the countries in which it has not yet been sold, but this overture has been declined.

In short, Mr. F. who knows english quite well, is going to reply direct to the U.S. Industrial Alcohol Company and suggests that we write also on our side but is positive that nothing useful

22/10

Plaintiff's Exhibit 22 (continued).

will be achieved unless some direct contact is established between a representative of the subject Company and himself to discuss technicalities and terms.

* * *

Ethylene is a by-product of cokeries and petroleum cracking; it can be manufactured from alcohol but the cost price if probably higher. Ethylene oxide has direct uses and is also an important intermediary in the manufacture of solvents, war gas, etc. 22/1.9

Plaintiff's Exhibit 22 (continued).

SOCIÉTÉ FRANÇAISE DE CATALYSE GÉNÉRALISÉE

PROCÉDÉS DE MONSIEUR LE PROFESSEUR CHARLES HENRY

Directeur honoraire de l'École des Hautes Études

Anonyme au Capital de 8 000 000 de francs

ELYSÉES 36-99
CATALYSE PARIS

SIEGE SOCIAL TRANSFERE
AU LABORATOIRE
20, Rue Pierre Lhomme
COURBEVOIE (Seine)
TÉL. : DÉFENSE 06-58

8, Avenue Percier
PARIS (VIIe)

Courbevoie le 13 Mars 1936.

U.S. Industrial Alcohol C°

60 East 42ndStreet

New York

Messieurs ,

Nous avons l'honneur de vous accuser réception de votre lettre du 26 Février ,que nous a remise vos amis The Guaranty Trust CY.

Nous ne demandons pas mieux que d'envisager une possibilité d'affaire avec votre Société pour les U.S. ,mais nous estimons qu'il est absolument indispensable avant toute chose que notre Société puisse avoir un contact technique avec un de vos représentants qualifié à cet effet .

Pensant que votre opinion sera conforme à la notre en cette circonstance ,nous vous prions ,Messieurs , d'agréer , mes salutations distinguées .

L'Administrateur
Directeur Général

[signature]

Munson Deposition Exhibit 3 for Identification
May 3, 1940
Stanley J. Cohara, Notary Public

Plaintiff's Exhibit 22 (continued).

March 24th
1926

Mr. Kent G. Colwell, Assistant Manager
Foreign Department
Guaranty Trust Company of New York
140 Broadway
New York City

Dear Mr. Colwell:

Many thanks for your very kind letter of March 23rd and for all the trouble you and your Paris office have taken in connection with our communications with the Ste.Francaise de Catalyse Generalisee. This is very much appreciated by all of us.

Faithfully yours,

C.S.Munson

CSM/cd

22/21

Plaintiff's Exhibit 22 (continued).

THE DISTILLERS CO. LTD.

TELEPHONE WHITEHALL 1040 (6 LINES)

TELEGRAMS "FERMENTER, LESQUARE, LONDON"

KINNAIRD HOUSE,
2, PALL MALL EAST,
LONDON, S.W.1.

April 16th 19[illegible]6.

C.E. Adams Esq'.,
Air Reduction Company,
Lincoln Building,
42nd Street
NEW YORK CITY. U.S.A.

Dear Adams,

I enclose herewith our Progress Report from the Research Department for the period ending 1st March, together with copy of a letter which Dr. Eyre has written to me.

We shall be very glad to answer any questions you may like to ask on the Report.

With kind regards,
Yours very sincerely,

Thos Board

Plaintiff's Exhibit 22 (continued).

3.

Hydration of olefines: No further experimental work has been done in so far as ethylene and propylene are concerned, attention having been directed to the hydration of butylene and higher olefines in the liquid phase at relatively low temperatures and pressures. As a result a small plant for continuous operation is being designed to test the possibilities of liquid phase hydration as applied to butylene, butadiene and amylenes, substances which are known to be formed as a result of cracking oil at the moderate temperatures of 700-750°C.

Ethylene oxide: The work on ethylene oxide has been continued with fair success and a larger plant estimated to produce about 1½ to 2½ kg. of ethylene oxide per day has been erected and is shortly coming into use. A good deal of difficulty has been experienced in getting suitable material from which to make the active catalyst, but it is expected to have this plant under way shortly. Satisfactory means have been worked out using charcoal for adsorbing and desorbing the ethylene oxide produced. The recovery of ethylene oxide, both in the form of ethylene oxide and glycol, seems to vary between 92% and over 100% of the ethylene oxide introduced. The amount of ethylene glycol recovered as such varies between 0.5 and 1.8% of the ethylene oxide used. This represents a 96.5% recovery of ethylene oxide and a total recovery as oxide + glycol of 97.4%.

Glycol ethers: Considerable work has been done on the direct conversion of ethylene oxide to glycol ethers, not only by the employment of tertiary bases as catalysts but when using certain solid catalysts. The best method so far arrived at consists in passing continuously a mixture of ethylene oxide with the appropriate alcohol over a chosen solid catalyst at temperatures of about 100°C and pressures of 5-10 atmospheres. In this way one is able continuously to prepare the desired glycol ether in a state of great purity, and containing only about 15% of the less desirable ethers of poly glycols. Present results show about 95% utilisation of ethylene oxide per passage over the catalyst.

LACQUERS:

Very little further work has been done on this subject, pending information as to the possible industrial application of lacquers to metal, wood and plaster board.

CELLULOSE TRIACETATE:

The demonstration plant referred to in the last report is now nearing completion, and the only experimental work being done in this particular field has reference to the application of cellulose triacetate for industrial purposes, which has necessitated a careful study of the question of solvents and plasticisers. In this connection it has been found, by very simple means, possible to prepare bottle caps having cellulose triacetate as a base instead of nitro-cellulose. In so far as these are able to carry pigments and

22/33

Plaintiff's Exhibit 22 (continued).

Munson Deposition Exhibit 4 for Identification
May 3, 1940
Stanley J. Cohara, Notary Public

April 29, 1936

Societe Francaise De Catalyse Generalisee
26 Rue Pierre Lhomme
Courbevoie (Seine)
France

Gentlemen:

We wish to acknowledge and thank you for your letter of March 12, 1936, and for your expression of good will toward our Company.

We are very much interested in a satisfactory process for the production of ethylene glycol and have looked into your U. S. Patent No. 1,998,078, as well as some of your French patents on the same subject. A study of these patents leaves some doubt in our mind as to whether your process as disclosed could compete with the well-known chlorhydrin process operated on a large scale in the United States at the present time.

It would help us very much to come to an early conclusion with respect to the applicability of your process in the United States and the advisability of sending one of our engineers to Paris, if you could tell us whether or not you have materially improved the process as outlined in the above mentioned patents; also whether either you or your licensees have carried out the operation on a sufficiently large scale to enable you to establish accurate cost data. We would like very much to know the largest scale on which your process has been operated to date and at what price you believe ethylene glycol could be manufactured, starting with pure ethylene at a cost of 2 1/2 cents per pound.

We would greatly appreciate an early reply, and beg to remain

Cordially yours,

LB

C. S. Munson
President

Plaintiff's Exhibit 22 (continued).

Munson Deposition Exhibit 5 for Identification
May 3, 1940 — Stanley J. Cohara, Notary Public

SOCIÉTÉ FRANÇAISE DE CATALYSE GÉNÉRALISÉE

PROCÉDÉS DE MONSIEUR LE PROFESSEUR CHARLES HENRY

Directeur honoraire de l'École des Hautes Études

Anonyme au Capital de 6 millions de francs

ÉLYSÉES 50 00.
CATALYSE PARIS

SIEGE SOCIAL TRANSFERE
AU LABORATOIRE
26, Rue Pierre Lhomme
COURBEVOIE (Seine)
TÉL. : DÉFENSE 00-69

8, Avenue Percier
PARIS

Courbevoie le II Mai 1936

Industrial Alcohol C°

50 East, 42ND Street

New-York

Messieurs,

Nous avons l'honneur de vous accuser réception de votre lettre du 29 Avril, dont nous vous remercions.

Malheureusement pour nos rapports futurs, nous sommes dans l'obligation de vous dire que les tractations que nous avions aux Etats-Unis, avant d'être en contact avec votre Compagnie, ont recemment abouti, et que nous avons cédés tous nos droits exclusifs pour les Etats-Unis, à la Carbide and Carbon Chemical Corporation.

Nous espérons bien vivement que nous aurons l'occasion dans d'autres domaines de faire des accords futurs avec votre Compagnie, et avec nos regrets nous vous envoyons, Messieurs, l'expression de nos sentiments les meilleurs.

L'Administrateur
Directeur Général

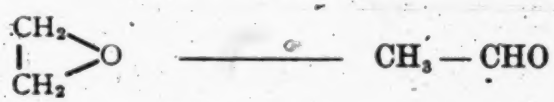
[signature]

See Distillers C Md file for correspondence in Jd 1936 re Société Française de Catalyse [illegible] with McBrown

Plaintiff's Exhibit 25.

BERICHTE (1903) p. 2017

Ethylene oxide, under the influence of aluminum oxide, was isomerized to acetaldehyde.



Plaintiff's Exhibit 27.

Translation of German Patent No. 547,641

Rheinische Kampfer-Fabrik G. M. b. H. in Düsseldorf-Oberkassel*)

*) The patentee as given by the patent solicitor is Dr. Josef Kathol in Düsseldorf-Oberkassel.

"Process for the Preparation of Acetaldehyde"

Patented in Germany as of December 10, 1930
Published March 29, 1932

* * * * *

On the other hand the surprising fact was established that silica gel is an outstanding catalyst for the transformation of ethylene oxide into acetaldehyde.

* * * * *

Plaintiff's Exhibit 28 for Identification.

FORMATION OF WATER

SUMMARY:

An experiment was carried out to investigate the rate of production of ethylene oxide and of carbon dioxide and water when ethylene and dried air were passed over a silver catalyst at a temperature within the range of 150-400° C. So far as could be determined formation of all of these compounds started simultaneously as soon as the reactants met the catalyst. Ethylene oxide and carbon dioxide plus water were produced throughout practically the entire length of the catalyst section.

EXPERIMENTAL:

These experiments were carried out in a 1-inch, oil-jacketed steel tube heated for a length of 36 inches. Temperatures were maintained at about 210° and recorded through a steel thermocouple well leading into the oil employed as the heat transfer medium. A stainless steel tube ⅛" in outside diameter extended through the center of the catalyst bed. The stainless steel tube was movable and was drawn down through the catalyst bed so that spot samples of the reaction products could be collected at various points in the catalyst mass.

The catalyst was prepared by evaporating to dryness an aqueous mixture of 97 grams of silver oxide and 250 cc. of 4 x 8 mesh carborundum. Two hundred cc. of this product were placed in the lower section of the tube mak-

Plaintiff's Exhibit 28 for Identification (continued).

ing a section 14½" long. The upper part of the tube was packed with inert material and served as a preheater. An air-ethylene mixture containing 5% ethylene was fed at the rate of 50 liters per hour. The air used was first passed through soda lime and calcium chloride to remove carbon dioxide and water.

In each instance, gas samples were collected from the exit end of the tube (Sample A) and from the stainless steel tube at various points in the catalyst bed (Sample B). The yields and efficiencies reported in the appended table were calculated from the results of analyses of these samples. Samples A were taken to show that the differences in composition of Samples B were due to the location in the catalyst bed and not to variations of the conditions during the run.

Qualitative tests for carbon dioxide were made by passing the gas through barium hydroxide solution and for ethylene oxide by the method of Deckert (Z. Angew. Chem. *45*, 559-62). Negative tests for ethylene oxide and carbon dioxide were obtained from the gas mixture just above the catalyst. Positive tests for both compounds were obtained just below the top of the catalyst indicating that these compounds were formed simultaneously. Additional quantitative data are given in the table.

The results prove that the production of ethylene oxide and of carbon dioxide and water continues throughout the length of the catalyst section, and that the ethylene oxide, carbon dioxide and water formed each gradually increases as the gas mixture is passed over an increasing length of catalyst bed.

Plaintiff's Exhibit 28 for Identification (continued).

Sample A		Sample B			
Single Pass Yield %	Eff. %	Single Pass Yield %	Eff. %	Ratio: Ethylene Oxide / Water	Sample Collected
19	57	1.4	44	0.41	½" below top of catalyst
21	62	2.5	58	0.70	1" below top of catalyst
21.5	65	3.4	56	0.63	1½" below top of catalyst
21	63	4.3	60	0.80	2" below top of catalyst
22	66	6.2	63	0.87	3" below top of catalyst
20.8	66	7.6	62	0.83	4" below top of catalyst
20.4	65	8.8	62	0.83	5" below top of catalyst
20.4	65	12.2	66	1.0	7" below top of catalyst
21.0	64	17.1	68	1.11	10" below top of catalyst
21.0	65	19.7	67	1.04	13" below top of catalyst
21.7	67	21.7	67	1.04	Just below bottom of catalyst

5-23-40

SUPPORTS

SUMMARY:

A series of one-day tests was carried out in which the following substances were used as supports for silver catalysts employed in the oxidation of ethylene to ethylene oxide: glass, fire clay, porcelain, asbestos, infusorial earth, Zeolite, magnesium oxide, carborundum, copper, zinc, pumice, Alundum, Filtros, barium sulfate and brick. Ethylene oxide was obtained with each.

A table of data is appended giving typical results obtained with each support.

In addition to these one-day tests, catalysts supported on carborundum, Alundum and Filtros were tested for several days. In each case the efficiency rose to above 60%.

EXPERIMENTAL:

These experiments were carried out in a 1-inch oil-jacketed, steel tube heated for a length of 36 inches.

Plaintiff's Exhibit 28 for Identification (continued).

Temperatures were recorded through a ¼-inch steel thermocouple well extending through the center of the tube. The catalyst was placed in the lower section of the tube surrounding the thermocouple well. The upper part of the tube was packed with inert material and served as a preheater. An ethylene-air mixture, usually containing about 5% ethylene, was fed at the rate of 50 liters per hour.

The catalysts were prepared by evaporating to dryness an aqueous mixture of 200 cc. of support and 77 grams of silver oxide. When possible the support was sized to 4 x 8 mesh. The volume of support was measured by loosely packing the material in 250 cc. graduate. The catalysts were reduced with hydrogen at 25 to 100° C. prior to use.

Most of the catalyst supports were washed with distilled water but in the case of the Zeolite 10% sulfuric acid was employed followed by the usual wash with distilled water. The Zeolite-supported catalyst as finally prepared also contained twice as much silver as the other catalysts.

With the exception of the Zeolite these supports were tested only once in this series of experiments. In the initial test with the Zeolite a rather active catalyst was obtained which did not form ethylene oxide but promoted complete oxidation to carbon dioxide. The Zeolite which is used as a water softener, contains a large amount of water-soluble alkali and it was thought that this was probably responsible for the undesirable promoting action on the silver. A second experiment was therefore carried out in which Zeolite was previously treated with 10% sulfuric acid and was coated with a larger amount of silver. This catalyst still had a pronounced tendency to form carbon dioxide but produced appreciable quantities of ethylene oxide.

Plaintiff's Exhibit 28 for Identification (continued).

DISCUSSION:

Although all of the substances tested could be broadly defined as supports a preliminary study would probably eliminate a number of them from further consideration without the need for any experimental work.

In general a support employed in a commercial scale vapor phase process should have certain desirable physical properties including the following:

1. It should be mechanically strong to resist shock and abrasion.
2. It should have a rather rough surface to which the catalyst will adhere well.
3. It should afford a minimum resistance to the flow of gases.
4. It should be cheap and readily available in large quantities.
5. In some cases porosity may be desirable.

It will be noted that among the supports tested are a number having very low mechanical strength and smooth surfaces. A substance such as asbestos would tend to pack tightly and impede the flow of gas. This is still more the case with finely divided materials such as ordinary infusorial earth or precipitated barium sulfate which is why these materials were tested in lump form in these experiments.

Perhaps the most important characteristic of a support is that it should be inert or that any effect should be beneficial. It is known that the materials known as "ceramics" are rather inert chemically. Carborundum, Filtros and Alundum, all of which have been subjected to high temperatures during their preparation, belong to this class of inert supports. Catalytically active forms of alumina and silica such as precipitated aluminum oxide or silica gel are, however, known to have a marked influence on the catalysts in some cases in which they have been employed as supports and might be expected to have some effect on the silver catalyst used in the oxidation of ethylene.

Plaintiff's Exhibit 28 for Identification (continued).

The undesirable action of Zeolite when employed as a support was not unexpected, since alkalis have been widely employed as catalytically active materials.

TABLE III

Support	Source of support	Single Pass Yield %	Efficiency %	Temperature ° C.
Pumice	Eimer and Amend	14.0	51.3	212
Glass	Pyrex, fritted, from Ace Glass Co.	8.8	63.9	200
Brick	Common red building brick	25	51	195
Filtros	Bonded silica, from Filtros Corp.	28	58	206
Carborundum	Bonded carborundum from Carborundum Corp.	16.5	53	212
Porcelain	Unglazed porcelain (Coors) plate from A. H. Thomas Co.	8.4	42	218
Infusorial earth	Infusorial earth bonded with 3% water glass	24.3	43	184
Zinc	Mossy zinc, technical grade from Eimer and Amend	30	37	210
Copper	Copper shot from Eimer and Amend	26.1	42.2	187
Barium sulfate	Barite from Barium Reduction Corp.	21.5	54	211
Magnesium oxide	Calcined magnesite obtained from Eimer and Amend	24.6	53	19[illegible]
Alundum	Bonded aluminum oxide from Norton Co.	27.1	30.6	207
Asbestos	Asbestos fiber, acid and alkali washed, from Eimer and Amend	9	31	207
Zeolite	A synthetic Zeolite, "Decalso", from The Permutit Co.	1.4	9	150
Fire clay	Fire brick	24.8	43	200

Plaintiff's Exhibit 28 for Identification (continued).

EFFECT OF VARYING GAS VELOCITY AND ETHYLENE CONCENTRATION

SUMMARY:

Experiments were carried out to obtain information regarding the effect of varying the concentration of ethylene in the air-ethylene mixture on the production of ethylene oxide. Seven concentrations of ethylene were tested varying from 6 to 80% ethylene.

Experiments were also conducted to determine the effect of varying the gas velocity on the efficiency of the ethylene oxide reaction.

EXPERIMENTAL:

These experiments were carried out in a 1-inch oil jacketed, steel tube heated for a length of 36 inches. Temperatures were recorded through a ¼-inch steel thermocouple well extending through the center of the reaction tube. The catalyst was placed in the lower section of the tube surrounding the thermocouple well and the upper part of the tube was packed with inert material and served as a preheater. The catalyst was prepared by depositing 77 grams of silver oxide on 200 cc. of 4 x 8 mesh carborundum. This silver oxide was then reduced in the tube with hydrogen at 25 to 100°C. The inlet gas was fed at the rate of 50 liters per hour and the temperature was maintained at 250°C. in the concentration experiments. In the velocity experiments the ethylene concentration in the feed gas was about 5% and the catalyst temperature was 260°C.

Additional details and a summary of the results are given in Table I and Table II which are appended.

Plaintiff's Exhibit 28 for Identification (continued).

TABLE I

Effect of Varying Ethylene Concentration

Ethylene Concentration %	Ratio, Air/ Ethylene	Ethylene Oxide Formed mgm/Liter of Exit Gas	Efficiency, %
80	0.25	20.2	46
65	0.52	64.9	63.5
33	2.0	78.4	61
25	3.0	97.7	60
14	6.1	71.9	65
10	9.0	54.1	67
6	15.6	37.8	65

TABLE II

Effect of Varying Gas Velocity

Rate of Feed of Gas, Liters/Hour	Ethylene Oxide Formed mgm/ Liter of Exit Gas	Efficiency, %
200	17.2	63
100	29.7	64
50	52.1	63

j
5-13-40

Plaintiff's Exhibit 28 for Identification (continued).

EFFECT OF ADDING WATER AND CARBON DIOXIDE TO THE INLET GAS

Summary

A series of tests was made in which ethylene was oxidized in the presence of a silver catalyst and of varying amounts of water vapor. The water vapor content of the entering gases was varied from 0.002% to about 3.5%.

The efficiency was not substantially affected by altering the moisture content of the entering gases. In some cases where the drier gases reacted too vigorously the moister gases gave ethylene oxide with better efficiencies. While the water vapor was found to repress the oxidation reactions, in general, the moister entering gases gave as high yields as the less moist gases but usually a somewhat higher temperature was required in the case of the more moist entering gases.

Other tests were carried out in which higher concentrations of water vapor were at times employed. Under certain conditions when dried inlet gases were being used and the temperature rose undesirably the addition of water rapidly restored the normal operating conditions even when the temperature had risen 40 to 50°C. above the optimum and the major portion of the ethylene was being burned to carbon dioxide and water.

Experimental

The catalyst employed was prepared by depositing 77 grams of silver oxide on 200 cc of 4 x 8 mesh Carborundum and reducing the oxide with hydrogen in the reaction tube at 25 to 100°C.

Plaintiff's Exhibit 28 for Identification (continued).

The reaction tube was an oil-jacketed 1-inch tube heated for a length of 36 inches. Temperatures were recorded through a ¼-inch thermocouple well extending through the center of the reaction tube. The catalyst was placed in the lower section of the tube surrounding the thermocouple well and the upper portion of the tube was packed with inert material and served as a preheater. An ethylene-air mixture was fed at the rate of 50 liters per hour to the reaction tube. Mixtures containing 5% and 10% ethylene were employed. Equipment was provided for drying the inlet gas to a dew-point not higher than —55°C. (0.002% water) or for saturating it with water to a dew-point of 26 to 27°C. (approximately 3.5% water). Under the best conditions of the test practically the same single-pass yield, about 45%, and the same efficiency, about 70%, was obtained with both the dried and moist gas but in general somewhat higher operating temperatures were required for the moist gases.

Similar tests made with carbon dioxide added to the inlet gas indicated that the effect of the carbon dioxide was practically the same as that of an equal volume of water vapor.

Tests with another sample of catalyst made in the same way were also carried out in an electrically-heated Pyrex reaction tube having dimensions similar to the steel tube previously described. An ethylene-air mixture containing 5% ethylene and saturated with water vapor at 40°C. (about 7% water) was fed to the reaction tube at the rate of approximately 50 liters per hour. Under normal operating conditions at a temperature of 216°C. ethylene oxide was obtained with a yield of 14.8% and an efficiency of 40%. When dry inlet gas having a dew-point below —55°C. was substituted for the moist feed gas a rapid rise in tem-

Plaintiff's Exhibit 28 for Identification (continued).

perature from 216°C. to 265°C. occurred over a period of ten minutes. Analyses of the exit gas carried out over a temperature range of 240 to 260°C. showed the ethylene oxide was being produced with a yield of 17.9% and an efficiency of only 23.7%. At a reaction temperature of 265°C. and while the temperature was still rising water was added to the inlet gas in such an amount that it formed about 60% by volume of the gas entering the reaction zone. The reaction temperature fell back to the normal operating temperature under these conditions in 10 minutes and operations were resumed with the water vapor concentration decreased to 7%.

6/4/40

Plaintiff's Exhibit 29.

PLAINTIFF'S INTERROGATORIES AND DEFENDANT'S ANSWERS

UNITED STATES DISTRICT COURT
DISTRICT OF MARYLAND

CARBIDE AND CARBON CHEMICALS CORPORATION
Plaintiff,
vs.
U. S. INDUSTRIAL ALCOHOL COMPANY
Defendant.

Civil Action File No. 183

1.

Plaintiff's Interrogatory. Since May 18, 1937, and prior to the filing of the complaint herein, has defendant, or any corporation in which defendant at the time owned and now owns a controlling stock interest, commercially practiced a process of making ethylene oxide by so subjecting a mixture containing ethylene and molecular oxygen at temperatures maintained between about 150° C. and about 400° C. to contact with an active surface catalyst comprising silver for direct oxidation of ethylene by molecular oxygen as to form oxidation products containing substantial amounts of ethylene oxide and not containing substantial amounts of aldehydes, and thereafter recovering ethylene oxide. (By "commercially practiced" is meant—conducted on a commercial scale in the regular course of business and producing a product or products for the purpose of sale and sold in the ordinary channels of trade, as distinguished from experimental or laboratory operations.)

Defendant's Answer. To plaintiff's interrogatory numbered 1, defendant's answer is: No.

2.

Plaintiff's Interrogatory. If the answer to Interrogatory 1 is in the affirmative, by what corporation or corporations and at what place or places was such process so practiced?

Defendant's Answer. To plaintiff's interrogatory numbered 2, no answer is required because defendant's answer to interrogatory numbered 1 is in the negative.

Defendant's Exhibit 46.

B. P. M. Laboratory Report No. 5205 (Portions relied on by plaintiff-appellee in addition to those printed in Defendant-Appellant's Supplement, p. 391 *et seq.*).

* * * * *

On March 30th and 31st a complete test, referred to below as "test 1", was made, an intake gas containing 9.2% ethylene and 18.8% O_2 being practically entirely converted in three cycles without intermediate addition of one of the components. The ethylene content after the third cycle was 0.3%. (When considering this last figure, as also almost all calculations in this report made from gas analyses, it should be taken into account that the *gas analyses* made according to Orsat *are inaccurate to several tenths %*, which, especially with highly diluted gases may result in a *considerable error in the percentage found.* A large number of analyses were made in an endeavor to eliminate this source of error as far as possible).

At my request the demonstration of the first cycle was repeated on April 8th especially with the object of trying to attain complete absorption of the ethylene oxide, whilst also CO determinations were made in the intake and the final gases. This test is referred to below as "test 2".

Appendices 2-5 incl. show in detail the results of the measurements made during said demonstrations, to which may be added the following:

Of course a qualitative reaction test on all products to be formed (ethylene oxide, glycol) was made in all the liquids used in the tests and analyses, but we also tested the absorption and washing liquids obtained for other oxidation products, such as aldehydes, acids, etc. To our great surprise neither the formation of aldehydes, nor of acids or CO was observed, whereas in all publications relating to the direct oxidation of ethylene, formaldehyde,

Defendant's Exhibit 46 (continued).

formic acid and acetaldehyde are mentioned as main or by-products of the partial oxidation (see e. g. *S. Lenher*, J. Am. Chem. Soc. *53*, 3762/1931).

In addition to a *trace of glycol* the only oxidation products found were *ethylene oxide and* CO_2.

* * * * *

For the oxidation of ethylene to ethylene oxide with elementary oxygen the most simple equation of reaction is:

$$2\ C_2H_4 + O_2 \longrightarrow 2\ C_2H_4O.$$

As appears from the numerous publications)1 concerning the oxidation of ethylene, it is very difficult to conduct the reaction in such a manner that a satisfactory yield in *oxide* is obtained. Below certain temperatures ethylene shows little reaction to oxygen, whilst oxidation catalysts readily cause the oxidation to proceed too far. Also high temperatures render it impossible to stop the reaction at a primary oxidation product. However, this primary oxidation product is practically always *formaldehyde*, of which it is easy to understand that at higher temperatures or with active catalysts it undergoes further oxidation or decomposition, the final products of which are *formic acid*, CO, H_2, H_2O and finally CO_2. For conversion into ethylene *oxide* it is necessary to choose such reaction conditions that the double bond of the ethylene is not *broken* up, thus low temperature and very specific catalysts. As, moreover, the rearrangement reaction

ethylene oxide ——— *acetaldehyde*

may give rise to considerable losses of ethylene oxide already formed, it is not surprising that reliable publications describing a process for the satisfactory manufacture of

Defendant's Exhibit 46 (continued).

ethylene oxide (or glycol in the presence of water) by oxidation are very scarce. As far as yields in ethylene oxide are mentioned in these publications, these appear to be inferior to the yield obtained by the S. F. C. G. during the demonstration; we would formulate our conclusion in this regard as follows: *Compared with the other processes so far described for manufacturing ethylene oxide by the reaction of ethylene with oxygen, the S. F. C. G. method gives the best yield, but it will still have to be calculated very carefully whether it is also superior to the methods whereby the oxide is obtained via ethylene chlorhydrine.*

* * * * *

Defendant's Exhibit 55.

SHELL UNION OIL CORP
80 BROAD STREET
NEW YORK

COPY OF MESSAGE
SENT

TO BRANDAN THE HAGUE DATE AUGUST 29, 1933

YOUF 284 REPORTS SHOW C. F. C. G. PROCESS SIMPLE METHOD PRODUCING ETHYLENE OXIDE HOWEVER AT COST DESTRUCTION ONE HALF OF ETHYLENE BY COMPLETE OXIDATION STOP

IF PROCESS APPLIED ON LARGE SCALE MUST PREPARE ETHYLENE AT CONSIDERABLE COST AND DESTRUCTION ONE HALF ETHYLENE BECOMES SERIOUS DISADVANTAGE TO BE BALANCED AGAINST SIMPLICITY IN COMPARING WITH OTHER PROCESSES STOP MOREOVER PATENT POSITION RATHER UNCERTAIN SEE GRATAMS'S LETTERS JULY 29TH AND THIRTYFIRST STOP

THEREFORE MY OPINION OPTION MUST BE EXTENDED FROM AUGUST 31ST TO DECEMBER 31ST TO ENABLE US FURTHER STUDY PROCESS FROM TECHNICAL ECONOMICAL AND PATENT VIEWPOINT BEFORE MAKING RECOMMENDATION FOR AGREEMENT BINDING US TO DEFINITE ROYALTY AND CASH PAYMENT STOP

CONSIDER ANYHOW ROYALTY FAR TOO HIGH AND CASH PAYMENT EXORBITANT BUT CAN ONLY MAKE DEFINITE COUNTER PROPOSALS AFTER COMPLETING STUDY AS MENTIONED ABOVE

D PYZEL

Defendant's Exhibit 63.

Translation

Memorandum on the conferences of Oct. 13 and 14, 1933 concerning the process of the Société de Catalyse Generalisèe, Paris, for the manufacture of ethylene oxide.

Present: Mr. Françon, Soc. de Catalyse Gènèralisèe, Paris

Messrs. Hardonk, Steenackers, Kilian, van Rossum } Bataafsche Petroleum Mij.

Mr. Francon gave us his confirmation that his Société is willing to extend the option for the American patents until Dec. 31, 1933; this will be confirmed by his Société. In the meantime, i. e., until Dec. 31, 1933 the Société de Catalyse Généralisée will not enter into negotiations with other companies concerning the U. S. patents.

* * * * *

Defendant's Exhibit 64.

LETTER dated November 3, 1933, from Masthoff to Jacobson (Portions relied on by plaintiff-appellee in addition to those printed in Defendant-Appellant's Supplement, p. 422).

• • • • •

Geneva's men (whether technical or not I do not know) saw the process exhibited in Paris and were entirely satisfied that the process is workable and that the quoted yields (of 40%) and costs are obtainable.

• • • • •

LVS
11/1/33

Defendant's Exhibit 79.

Postal Telegraph

THE INTERNATIONAL SYSTEM

-N38 74/73 CABLE=PARIS 404P MAR 12 1936

LC DAVIDSON JAYGEDEE=

=NEWYORKNY (DAVIDSON DR J G DAVIDSON CARBIDE AND CARBON CHEMICALS 60 EAST 42 ST RM 1602)=

=FRANCON HAS GIVEN ME NO FIGURE YET FOR SELLING EXCLUSIVE LICENSE HE WILL SEE THE CHAIRMAN PROBABLY SEVENTEENTH MARCH AND GIVE ME HIS TERMS FOR AN OPTION FOR YOU ON ROYALTY BASIS STOP NUMBER AMERICAN PATENT IS 1.998.878 WHICH IS SUFFICIENT TO WORK PROCESS STOP THERE ARE TWO APPLICATIONS OUTSTANDING CONCERNING SIMPLIFICATION IN PREPARATION CATALYST BUT THEY ARE STATED NOT TO BE FUNDAMENTAL AND ARE SECRET FOR PRESENT=

=CHALAS.

1155A

Defendant's Exhibit 91.

JOURNAL OF THE FRANKLIN INSTITUTE

Volume 194, No. 1, July, 1922

"CATALYSIS AND CATALYTIC AGENTS IN CHEMICAL PROCESSES"

by

HUGH S. TAYLOR

(Portions relied on by plaintiff-appellee in addition to those printed in Defendant-Appellant's Supplement, pp. 479 *et seq.*)

* * * * *

The active catalyst is normally a porous, amorphous material and, in process of activation, catalysts tend to assume this form.

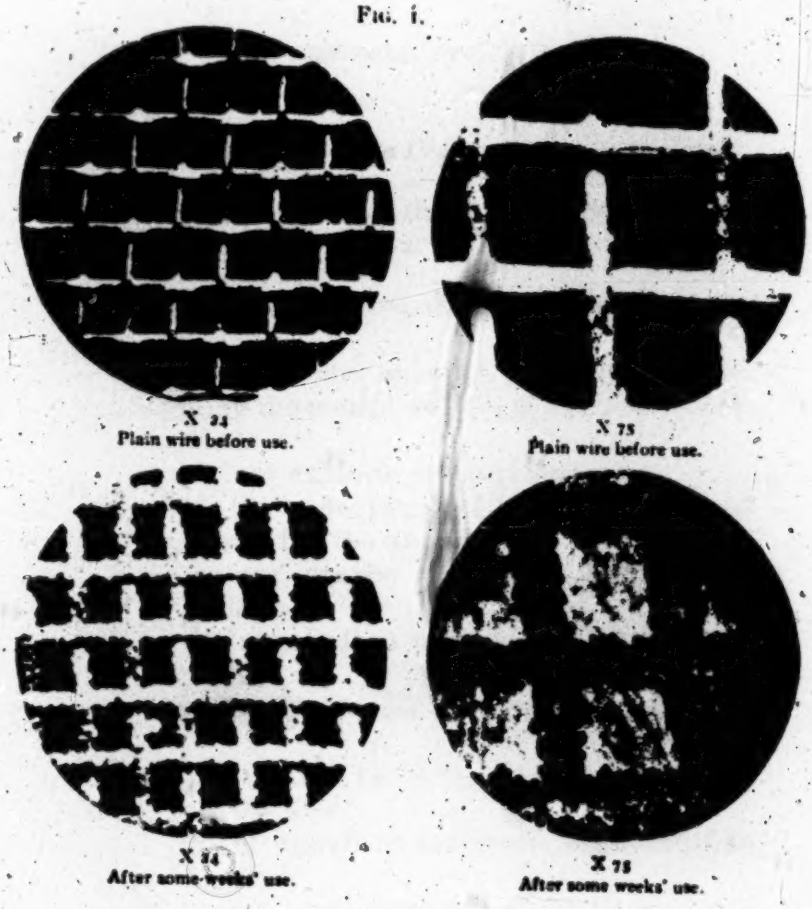
* * * * *

The change is most strikingly manifested in the microscopic examination of platinum gauze before and after use in the oxidation of ammonia. The gauze is converted from a

Defendant's Exhibit 91 (continued).

smooth plane-surfaced wire to a corrugated pitted material. This is shown in the accompanying figure. Similar changes

FIG. 1.



X 24
Plain wire before use.

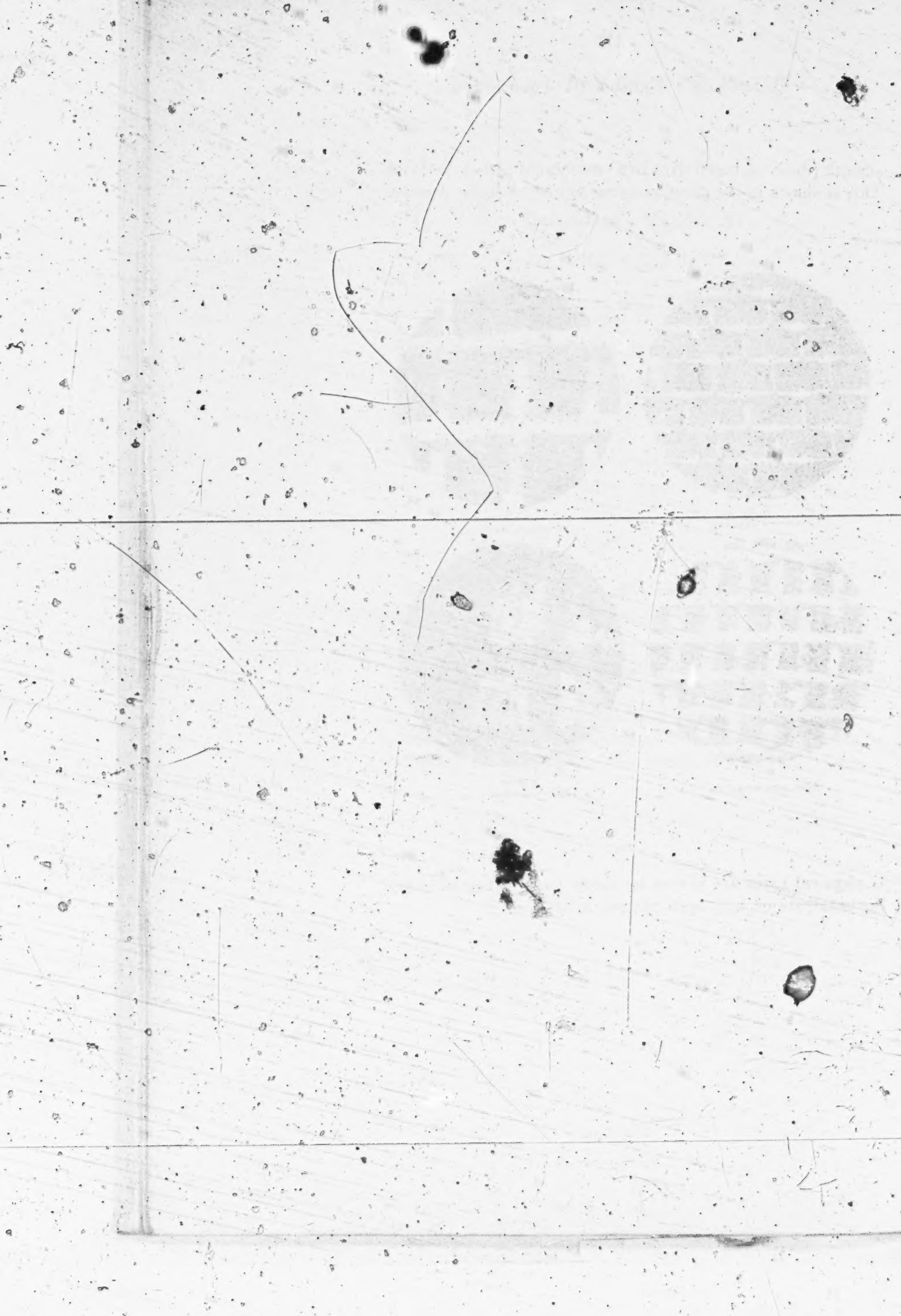
X 75
Plain wire before use.

X 24
After some weeks' use.

X 75
After some weeks' use.

in physical form are shown by silver gauze when used for the catalysts of hydrogen oxygen mixtures.

• • • • •



[fol. 172] PROCEEDINGS IN THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE FOURTH CIRCUIT

No. 4774

U. S. INDUSTRIAL CHEMICALS, INC., Appellant,

versus

CARBIDE AND CARBON CHEMICALS CORPORATION, Appellee

Appeal from the District Court of the United States for the District of Maryland, at Baltimore

February 26, 1941, the transcript of record is filed and the cause docketed.

Same day, motion and orders extending the time to February 26, 1941, for filing the record on appeal and for docketing the appeal are filed.

Same day, the original exhibits are certified up.

February 28, 1941, the appearance of L. A. Watson and C. V. Johnson is entered for the appellee.

March 1, 1941, the appearance of Dean S. Edmonds is entered for the appellant.

March 3, 1941, the appearance of Harry N. Baetjer is entered for the appellant.

March 17, 1941, plaintiff's exhibit #3 (Operating Model) is certified up.

March 18, 1941, stipulation as to the time for the filing of the respective briefs is filed.

Same day, petition of appellant for leave to file brief in excess of 50 pages is filed.

March 21, 1941, order permitting appellant to file brief in excess of 50 printed pages, but not exceeding 85 printed pages, is filed.

April 1, 1941, brief and supplement on behalf of the ap-
[fol. 173] pellant are filed.

April 9, 1941, petition of appellee for leave to file brief in excess of 50 pages is filed.

Same day, order permitting appellee to file brief in excess of 50 printed pages, but not exceeding 60 printed pages, is filed.

April 11, 1941, brief and appendix on behalf of the appellee are filed.

April 15, 1941, reply brief on behalf of the appellant is filed.

Argument of Cause

April 18, 1941, (April term, 1941) cause came on to be heard before Parker, Soper and Dobie, Circuit Judges, and was argued by counsel and submitted.

[fol. 174] Opinion—Filed June 27, 1941

United States Circuit Court of Appeals, Fourth Circuit

No. 4774

U. S. Industrial Chemicals, Inc., Appellant,

versus

Carbide and Carbon Chemicals Corporation, Appellee

Appeal from the District Court of the United States for the District of Maryland, at Baltimore

(Argued April 18, 1941. Decided June 27, 1941)

Before Parker, Soper and Dobie, Circuit Judges.

Dean S. Edmonds (Venable, Baetjer & Howard; Frank E. Barrows, Charles W. Riley and Frederick L. Bissinger on brief) for Appellant; and Leonard A. Watson (Hershey, Donaldson, Williams & Stanley; C. V. Johnson and C. W. Fairbank on brief) for Appellee.

[fol. 175] Dobie, Circuit Judge:

Carbide and Carbon Chemicals Corporation (hereinafter called plaintiff) brought a civil action in the United States District Court for the District of Maryland against U. S. Industrial Chemicals, Incorporated (hereinafter called defendant), for the alleged infringement of a patent. Judge Coleman, in the District Court, found the material issues in favor of plaintiff and directed that plaintiff recover from defendant profits, gains, advantages and damages, with a reference to a master to ascertain and report to the Court an account of these profits, gains and advantages and to assess the proper damages. Defendant duly took this appeal.

The United States Patent Office granted to Theodore E. Lefort patent #1,998,878 (hereinafter called the original patent), dated April 23, 1935, covering a process for the production of ethylene oxide. Plaintiff was the assignee of the patent. Later, a reissue patent (hereinafter called the reissue patent), Re. #20,370, dated May 18, 1937, was obtained from the United States Patent Office. Plaintiff's claims of infringement relate to the reissue patent and more specifically to Claims #8 and #9 of this patent.

Accordingly, though there are other issues involved in this case, there are two very vital questions that must be considered. The first question involves the validity of the reissue patent, particularly Claims #8 and #9. The second question, if such validity be sustained, is concerned with the infringement by the defendant.

The Validity of the Reissue Patent

The point most seriously advanced by defendant, both in the briefs and in oral argument, is the invalidity of the reissue patent, particularly Claims #8 and #9, on the ground that the process disclosed in the reissue patent involves a substantial and material (even an essential) va- [fol. 176] riance from the process set out in the original patent. More precisely, defendant claims that, in the process for the production of ethylene oxide under the original patent, the voluntary addition of water into the reaction-chamber is not only mandatory but is an essential step in this process; while under the reissue patent, the process calls for no voluntary introduction of water into the reaction-chamber. It is absolutely clear that, with or without this voluntary introduction of water, some water is, and must be, there formed through a side-reaction in the process.

The law is clear, under the reissue statute (Rev. St. § 4916; U. S. C. A., Title 35, § 64), that there can be no reissue patent for a new invention. Indeed, the cases go much further than this to hold that the reissue patent is invalid if, between the inventions disclosed first in the original patent and then in the reissue patent, there be variances that are essential, substantial and material. A leading case is *Parker & Whipple Co.* v. *Yale Clock Co.*, 123 U. S. 87, —— S. Ct. ——. Other important cases are *Seymour* v. *Osborne*, 11 Wall. 516, —— S. Ct. ——; *Powder Co.* v. *Powder Works*, 98 U. S. 126, —— S. Ct. ——; *Mahn* v.

Harwood, 112 U. S. 354, —— S. Ct. ——. And the United States Supreme Court has cited and applied the *Parker & Whipple Co. case, supra*, in *Matthews* v. *Ironclad Mfg. Co.*, 124 U. S. 347, 351, —— S. Ct. ——; *Yale Lock Co.* v. *James*, 125 U. S. 447, 464, —— S. Ct. ——; *Corbin Cabinet Lock Co.* v. *Eagle Lock Co.*, 150 U. S. 38, 42-43, —— S. Ct. ——. And see, decided by this Court, the cases of *Marvel Buckle Co.* v. *Alva Mfg. Co.*, 196 F. 1006; *A. D. Howe Machine Co.* v. *Cooffield Co.*, 197 F. 541. Yet a reissue patent is not invalid merely because the reissue patent contains claims broader than the original, *Topliff* v. *Topliff*, 145 U. S. 156, —— S. Ct. ——, or claims narrower than the original, *Miller* v. *Brass Co.*, 104 U. S. 350, —— S. Ct. ——.

In the instant case, the original patent (all italics are [fol. 177] ours) thus begins: "This invention has for object a process for the production of ethylene oxide which mainly consists in subjecting ethylene to the simultaneous action of the oxygen of air and of *water* in presence of a catalyzer and, if need be, of hydrogen." Later, the patent (page 1, column 2, lines 10-11) states: "*Water* can be *admitted* (not formed or developed) in the reaction vessel, either in the liquid state, or as steam." Also we find (page 1, column 2, lines 15-16) "*introduction*, (again a word of conscious action) in this reaction, of a suitable quantity of *water*." Again (page 1, column 2, lines 36-43) is: "if *water* is *introduced* in suitable quantity, the reaction is not only facilitated, as above stated, but, in addition, the reaction giving CO_2 (carbon dioxide) * * * is checked." (Words in parentheses are interpolated).

Three modi operandi are set out in the original patent. In the first, there is (page 2, column 1, line 18) "a circulating pump allowing to *introduce water*", and (page 2, column 1, lines 20-21) "The reaction will take place in this tube between ethylene, the oxygen of air, and water." In the second (page 2, column 1, lines 33-35), is "a mixture of ethylene, air, *water* vapour, and hydrogen is *caused to pass* therethrough (through the tube)." And, in the third (page 2, column 1, lines 41-44), is: "A silver colloid is introduced in a high pressure tube which *has been filled* with *water*. Pure ethylene under pressure is *then* added in order that it can dissolve in the water"; and (page 2, column 2, lines 3-5): "*Water*, in the form of steam or not, *considerably promotes the reaction ensuring* the production of ethylene oxide."

Not so strong (as to the voluntary introduction of water into the reaction chamber) is the language in the original patent of the seven claims. The first three claims *each* begin (page 2, column 2): "A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and *water*." In claims 3 and [fol. 178] 4 (page 2, column 2) the language is identical, save that the word "steam" (a form of water) is substituted for the word "water". While in claims 6 and 7 (page 2, column 2) after the word "oxygen", we find the words "steam and hydrogen".

Apart from this verbal analysis of the original patent, we have made a careful study of the record. We are convinced that this original patent contemplated the voluntary introduction of water into the reaction-chamber, not as an optional procedure, but as a step that would always be taken. The verbal analysis shows that, in the original patent, literally there is "Water, water, everywhere". Nor is it water developed as a by product, but it is water voluntarily introduced into the tube to bring about the desired reaction. There is some expert testimony in the record which might seem to prove the contrary. This testimony, *as to the specific point now before us*, is considerably weakened by two considerations. These experts were super-chemists of unusual distinction; they were not the patentee Lefort. They drew not only upon their vast store of technical knowledge, but they used, too, what developments (and these were far from inconsiderable) had been made in the whole field of the Lefort patent since application for this patent was made by the inventor. Some study of chemical history and literature, as these existed at the time of Lefort's labors, convinces us even more strongly of the truth of the conclusion that the voluntary introduction of water was a mandatory provision of the original Lefort patent.

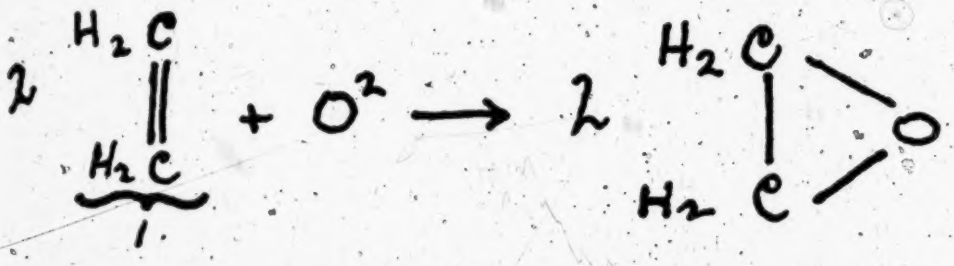
It seems quite clear, on the other hand, that the reissue patent does *not* contemplate the voluntary introduction of water into the reaction-chamber as a necessary step in the procedure. There is no mention of the word "water" in the introductory paragraphs of the reissue patent (apart from an incidental statement on page 1, column 1, line 23, that oxidation of ethylene gives some carbon dioxide and [fol. 179] water). Indeed, the word "water" is not found until the 39th line of page 1, column 1, and note how different

is the language here used, when compared with the language of the original patent. Here we find (page 1, column 1, lines 39-42): "*Some water* or carbon dioxide in addition to that formed *can* be admitted to the mixture in the reaction zone if desired." And the word "water" occurs only once more in the reissue patent before the claims are set out. We find (page 1, column 2, lines 12-16): "Ethylene and oxygen are thus reacted simultaneously at the temperatures set forth *in the presence of a surface catalyst and water.*" Claims #1 to #7 in the reissue patent present no important differences from the like-numbered claims in the original patent. Added Claims #8 and #9 (the claims at issue in the instant civil action) each use the word "water" but once, in the expression "to form oxidation products containing ethylene oxide *in the presence of water*" (Claim #8, page 2, column 1, line 35, and Claim #9, page 2, column 2, line 25). In reference to the use of "water", such verbs as "admitted" or "introduced", with the single exception first discussed above when the term "admitted" is most carefully qualified and restricted, are conspicuous by their absence from the reissue patent.

This brings us to what we regard as the most crucial problem in the case. Are Claims #8 and #9 of the reissue patent so vitally and so substantially different from the original patent as to invalidate these claims? We have just held that *there is a difference* here in that the original patent contemplated the voluntary introduction of water into the reaction-chamber (distinguished from the mere formation of water during the course of the reactions) as a step that would always be taken in the procedure therein set out, while Claims #8 and #9 contain no such requirement, and indeed seem to negative clearly any such step. Is this difference vital, essential, substantial, material? [fol. 180] Judge Coleman answered this question categorically in the negative, in his findings of fact number 7 and number 8. Under Civil Rules of Federal Procedure, Rule 52(a), we can set aside these findings if, but only if, in our opinion the findings are "clearly erroneous". We do not think these findings are "clearly erroneous", so we must affirm them.

The Lefort process was one for the production of ethylene oxide C_2H_4O, by a direct chemical combination between ethylene, C_2H_4, which is a hydro-carbon gas, and oxygen. The chemical formula for this conversion, as set

out in the original patent (page 1, column 1, lines 11-14), is thus written:



This means that 2 molecules of ethylene plus molecular oxygen (2 atoms) will produce 2 molecules of ethylene oxide. This chemical formula had long been known. The difficulty was to find some practical process for bringing about the reaction prescribed by the formula. Some eminent chemists had stated that no such process would ever be found. The process described in Claims #8 and #9 of the reissue patent does constitute such a process, and there is no doubt of the real practical importance and the great commercial value of this process.

We think it is fair to state, in the light of the record in this case, that under the original patent, the essentially vital aspects of the process are (1) subjecting ethylene to the action of the oxygen of air; (2) in a reaction-chamber at controlled and specified temperature; (3) in the presence of a designated type of catalyst. The role of the water deliberately introduced into the reaction chamber was to increase and facilitate the efficiency of the reaction [fol. 181] by diminishing the quantities of carbon dioxide and other undesirable by-products which might result from the reaction. Water would furnish a cheap and available heat-absorbing diluent. Lefort, of course, knew of the presence of some moisture in air. However, the original patent does not mention the quantity or proportion of water that was to be voluntarily introduced. There is mention, in the third modus operandi, of a "tube which has been filled with water"; but just before the setting out of the three modi operandi, we find the statement: "Several modi operandi for carrying the process into practice, will be indicated hereinafter, by way of example only." The specifications of the original patent indicate the introduction "of a *suitable quantity* of water" (page 1, column 2, lines 15-16) and "if water is introduced in suitable quantity" (page 1, column 2, lines 35-36).

There are a very few differences between Claims #8 and Claim #9 of the reissue patent, and these differences are hardly of very great importance. Claim #8 mentions "a mixture containing ethylene and molecular oxygen"; Claim #9 adds to this the words "and a heat-absorbing diluent". Claim #8 mentions a "catalyst of a material having the catalytic characteristics of silver". In Claim #9 we find "catalyst material composed essentially of silver". Claim #8 ends "and thereafter recovering ethylene-oxide-containing product in liquid form". Claim #9 concludes "and thereafter separating ethylene oxide from the products of oxidation."

Claim #8 of the reissue patent is reproduced in full, with the numerals therein inserted by Judge Coleman to indicate the language covering the six steps embraced in the process:

"In both claims 8 and 9, the process set forth for the production of ethylene oxide embraces six steps. We quote claim 8 in full, and have inserted numerals indicating the language in the claim which covers these steps: 'The process of making ethylene oxide by the direct chem- [fol. 182] ical combination of oxygen with ethylene in the proportions of one atom of oxygen to one molecule of ethylene, which comprises (1) forming a mixture containing ethylene and molecular oxygen and (2) conducting said mixture through a confined reaction zone which is maintained at an elevated temperature; (3) controlling said temperature to maintain said mixture in said zone at a temperature between about 150° and about 400° C.; (4) subjecting said mixture in said zone at said elevated controlled temperature to intimate contact with an active surface catalyst of a material having the catalytic characteristics of silver which favors the direct oxidation of said ethylene in said mixture by said molecular oxygen to form oxidation products containing ethylene oxide in the presence of water, and which does not favor the existence in said products of substantial amounts of aldehydes; (5) correlating the passage of said mixture through said reaction zone in the presence of said catalyst and the controlled elevated temperature of said mixture and said catalyst to effect said oxidation of said ethylene directly to form substantial amounts of ethylene oxide; and (6) thereafter recovering ethylene oxide-containing product in liquid form.'"

This process is thus described by Judge Coleman in his opinion:

"Shorn of technical phraseology and summarized very briefly, the process may be described as consisting of the passage of a mixture of ethylene gas and air through a tube containing a silver catalyst heated to a control temperature between approximately 150° and 400°. The direct combination of the air with the ethylene produces ethylene oxide. A side reaction also occurs in that there is destructive oxidation of some of the ethylene, producing carbon dioxide and water. It is claimed in the introductory statements of the patent that 'This process is characterized by an entirely unique reaction in which the direct addition of a single oxygen atom to the ethylene molecule occurs without the formation of significant amounts of other ox-genated compounds such as aldehydes.' That is to say, the product is claimed to be a notably clean one, —pure ethylene oxide, in readily recoverable form."

The expert testimony here strongly favors the conten- [fol. 183] tions of the plaintiff. Professor Lamb, after a series of experiments, testified that one skilled in the art would, by following the original patent, successfully produce ethylene oxide, whether the introduction of water be regarded as mandatory or optional, and that he would obtain the same practical result by following the teachings of the reissue patent. In no uncertain terms, he gave his opinion, based upon his experiments conducted before he had ever seen the reissue patent, that, if it be assumed that the original patent required the introduction of water and the reissue patent omitted this requirement, this, from the technical viewpoint of chemistry, would not constitute a material or substantial variance. Professor Lamb remained at the trial and was recalled and asked by Judge Coleman: "Have you, since you testified, had a chance to study the reissue patent?" Professor Lamb replied: "Last evening I read it for the first time, so I have some familiarity with it." To the court's question "Well, then, do you feel you are in a position to testify more fully now from a scientific standpoint as to whether you find any material difference on this question that has been dwelt upon so much, the departure, in that water is required in the first patent and not in the second, as an addition?", Professor Lamb's reply was: "I certainly have not heard anything

that has changed my ideas about water as an ingredient in this reaction."

The testimony of Professor Lamb was strongly confirmed by the evidence of Professors Frazer and Stevenson and of Dr. Curme, director of research for plaintiff. Professor Frazer stated emphatically: "In my judgment, the amount of water or the manner in which it was added was not the important thing at all. Speaking entirely as a chemist." Again, he stated: "As far as I could make out in regard to this question of water, it is a very much over-worked topic."

The testimony of the experts introduced by defendant, [fol. 184] we think, does not bear favorable comparison with the testimony of the experts introduced by plaintiff. Nor was defendant helped by virtue of the fact that Judge Coleman appointed Professor Frazer as an inter-partes expert witness in order that experimental tests might be made in advance of the trial and defendant produced no witness who had made, or who co-operated with Professor Frazer in making any inter-partes tests along the lines of either the original patent or the reissue patent.

Two points have been suggested to us, which, it is said, should heavily discount the value, in this connection, to the plaintiff of its expert witnesses in general, and of Professors Lamb and Frazer particularly. These are not merely ordinary men "skilled in the art". See U. S. C. A. Title 35, Section 33. They are superior supermen in the science of chemistry, to whom, in the light of their vast knowledge, the specifications and claims of a patent suggest possibilities that did not occur to the patentee and would not occur to the ordinary skilled man. Again, these super chemists are primarily interested in the scientific chemical possibilities of a patent; but they have little interest or knowledge in the patent law and the monopoly thereby granted to an inventor, or in practical commercial considerations such as the fact that if water, here, be voluntarily introduced into the reaction-chamber in appreciable quantity, the expense and trouble involved in heating this water to the desired temperature would materially enhance the costs of production. We have given due weight to these suggestions which, in our opinion, have some unquestioned force. Yet, even after such weight has been given, we still think their testimony, set against, and read

in the background of, the entire record of the instant case, affords ample warrant for the findings by Judge Coleman.

Defendant contends that the language of the patents here in suit is addressed to, and must be interpreted by, "persons skilled in the art or science to which it appertains" (U. [fol. 185] S. C. A. Title 35, Section 33), rather than by such super-chemists as the expert witnesses who testified for plaintiff. In *Seymour* v. *Osborne*, 11 Wall. 516, at pages 545-546, we find:

"Whether a reissue patent is for the same invention as that embodied in the original patent or for a different one is a question for the court in an equity suit to be determined as a matter of construction, on a comparison of the two instruments, *aided or not by the testimony of expert witnesses, as it may or may not appear that one or both may contain technical terms or terms of art requiring such assistance in ascertaining the true meaning of the language employed.* * * *

Cases doubtless arise where the language of the specification and claim, both of the surrendered and reissued patents, is so interspersed with technical terms and terms of art that *the testimony of scientific witnesses is indispensable to a correct understanding of its meaning.*" (The italics are ours).

The very field of the instant patents, catalytic chemistry, is a highly specialized one in which there have been developments that are many and important. The question of substantial variance *vel non* between the two patents, original and reissue, is close and troublesome due in no small measure to the difficulties involved not only in analytically interpreting and applying individual words of a highly technical nomenclature, but also in mentally envisaging complex chemical processes in their entirety and in accurately and fairly comparing these processes when so envisaged. We, accordingly, think our case falls squarely into the category described in *Seymour* v. *Osborne*.

Defendant attempted to make much of other French and British patents, which, like a scarlet thread, run through defendant's brief. Any adequate discussion of these foreign patents, in this connection, would unduly prolong this opinion. In answer to defendant's contention, however, that the reissue was largely an embodiment of the

[fol. 186] details set out in these foreign patents, it may be pointed out that the lawyer who had charge of the application for the re-issue patent testified, without contradiction or impeachment, that he then had no knowledge whatever of the details of these foreign patents.

The specifications of the original patent, at the most, did not add to the elements called for by the claims, but merely contained an inadvertent error as to one step in the process (i. e., the voluntary introduction of water), and that not one of the most important steps, in the process by which these elements were to be brought into functional relation. A reissue patent would seem to be a proper method for the correction of such an error. And, if claims #8 and #9 of the reissue patent had been added to the claims of the original patent, we do not believe these claims could have been held to be invalid on the ground that these claims were not sufficiently covered by the specifications of the original patent.

Minor Defenses

We regard the issue of a substantial variance between the original patent and the reissue patent as the vital question involved in this appeal. Having resolved that question in favor of the plaintiff, we now proceed to certain minor defenses set up by defendant. Judge Coleman, in his opinion, considered and dealt with these minor defenses at some length. He decided that all of them were lacking in merit. We believe all these rulings to be correct and the reasons on which they were based to be sound. We shall advert somewhat briefly to each of these minor defenses.

Defendant attacks the validity of the original patent on the ground that under the prior art this patent lacks patentable novelty. Even a cursory reading of the testimony of Professor Lamb, Professor Stevenson and Dr. Curme should effectively silence this contention. The Lefort [fol. 187] process provided a practical and original solution to a problem that had long baffled industrial chemists. We certainly do not believe that the original patent was anticipated by the McElroy patents, for the McElroy patents were demonstrated to be quite unworkable in any practical commercial sense, and these patents fail to disclose the essential features of Lefort's original patent.

The federal Reissue Statute (59 Rev. St. §4916; 35 U. S. C. A. §64) permits a reissue patent only if error in an original patent "has arisen by inadvertence, accident or mistake, and without any fraudulent or deceptive intention." The evidence amply sustains the finding of the United States Patent Office (See *Topliff* v. *Topliff*, 145 U. S. 156, —— S. Ct. ——), affirmed by Judge Coleman, that the conditions set out in the Reissue Statute have been adequately satisfied here. There is little force in defendant's contention that the claims and specifications of the original patent were fraudulently or deceptively made vague and indefinite. Unusually convincing in this connection, are the testimony of plaintiff's attorney and the affidavit of the French attorney. This seems to be a typical case of a valid, original basic patent, in which the claims were inadvertently drawn in terms that were too narrow and these claims were, accordingly, subject to valid correction under a reissue patent.

Another contention is that Claims #8 and #9 of the reissue patent specify the catalyst only in terms of function. The testimony of Professor Lamb disposes of this contention. He was amply confirmed here by Professor Stevenson's evidence and particularly the testimony of the latter dealing with the literature of silver catalysts, including the notable contributions on that subject of Professor Benton (a catalytic chemist of outstanding distinction) and Mr. Elgin. Nor was there much encouragement to defendant here in the testimony of its own expert, Mr. Ray Carter. We have no reasonable doubt that the description of the catalyst would be entirely sufficient to [fol. 188] enable one versed in the art to follow satisfactorily the outlined process.

Defendant asserts that plaintiff has failed to disclaim claims #2, #4, #5, #7 of the reissue patent, though the invalidity of these claims was brought to the attention of the plaintiff in the answer of the defendant, and that this fact makes the reissue patent invalid in its entirety. These claims have never been adjudged to be invalid, nor do we think their invalidity is clearly apparent upon an inspection of the patent. The approval of these claims by the Patent Office would seem to raise some presumption, until the contrary appears, that the claims are valid. It is at least open to very serious doubt whether "the making of the invalidity of these claims obvious" by a mere asser-

tion to that effect in its answer would relieve the defendant from liability for infringement of claims #8 and #9 committed prior to the filing of this answer. Claims #8 and #9, (not the narrower claims #2, #4, #5, #7) form the basis of the instant action.

Said Judge Coleman on this point: "A patent will not be invalidated for mere failure on the part of the patentee to disclaim prior to some judicial decision upon the subject matter, i. e., upon one or more of the claims of the patent. After that, the patentee must act with diligence in accordance with the result of the adjudication." And in Robinson on Patents (1890) vol. 2, page 284, we find the following language, cited with approval in *Easter* v. *Simon, Ascher,* 282 U. S. 445, 453: "In cases where the excess is not apparent at once upon the inspection of the patent by the patentee, the allowance of his claim by the Patent Office raises such a presumption in his favor that he may rely upon its validity until a court of competent jurisdiction decides that it is broader than his real invention." The cases of *Easter* v. *Simon, Ascher,* 282 U. S. 445; *Triplett* v. *Lowell,* 297 U. S. 638; *Maytag Co.* v. *Hur-*
[fol. 189] *ley Machine Co.,* 307 U. S. 242, *Radio Condenser Co.* v. *General Instrument Corp.,* 65 F. (2d) 458 (cited in the brief of defendant); do not go beyond what is written above. Hence, they do not sustain the interpretation sought to be placed upon them by the defendant.

If Claims #8 and #9 of the reissue be valid (and we do so hold), we think there can be little doubt of infringement by defendant. Indeed, we do not believe defendant's contention to the contrary was very seriously urged. The deadly parallel between the process of the reissue patent and the process employed by defendant, set out in plaintiff's exhibits #8 and #9, which was not successfully contradicted by defendant, is quite sufficient here.

Defendant's last defense is in the nature of an attempt to invoke against plaintiff an equitable estoppel, based largely on expenditures by defendant before the issuance of the reissue patent. Defendant is here clutching for a very feeble straw. *Sontag* v. *National Nut Co.,* 310 U. S. 281, —— S. Ct. ——, and *Otis Elevator Co.* v. *Atlantic Elevator Co.,* 47 F. (2d) 545, are clearly distinguishable on the facts from the instant case. The expenditures in question were largely for experimental purposes. Even as to these, the evidence is far from clear as

to just how much money was expended before, and just how much after, the application for the reissue patent. As Judge Coleman observed:

"But it appears that defendant never began to construct its present costly plant until after the reissued patent had been granted; and never began to operate it commercially for the production of ethylene oxide until more than two years later. It is a correct inference from the testimony that prior to the application for the reissued patent, defendant's work on this process amounted to relatively little, but that thereafter, defendant zealously progressed its development of plant and process, with a view to capitalizing what plaintiff had done."

[fol. 190] *General Considerations*

We believe that what might be called the general equities here strongly favor the plaintiff. A French inventor, Lefort, made a discovery of great scientific importance and unquestioned commercial value. Plaintiff acquired the original patent, which was perfected by a reissue patent. It cannot fairly be said that plaintiff merely bought a lawsuit or tried to play the role of a dog in the manger. And this is true, even though there may have been some doubt as to the validity of the patents in question.

On the other hand, the activities and expenditures of defendant in connection with ethylene oxide were comparatively slender before application was made for the reissue patent. The erection of defendant's elaborate plant in Baltimore after the issuance of the reissue patent, and defendant's elaborate activities thereafter were all in the nature of a gamble on the invalidity of the reissue patent by the defendant's officers, who hoped, if they were thus fortunate, to prosper by the appropriation of the intellectual property of another. If, through over-hasty action, this chance broke against defendant, we see little need for the shedding of any crocodile tears over the misfortune thus brought on the defendant.

Finally, we are impressed by the general nature of the defenses set out at length by the defendant in a desperate effort to escape the consequences of a palpable infringement. These defenses, terribly technical in the extreme, contain little or no appeal to the beneficent principles of equity and good conscience.

For the reasons set forth above, we affirm the judgment of the District Court.

Affirmed.

[fol. 191] DECREE—Filed and Entered June 27, 1941

UNITED STATES CIRCUIT COURT OF APPEALS, FOURTH CIRCUIT

No. 4774

U. S. INDUSTRIAL CHEMICALS, INC., Appellant,

vs.

CARBIDE AND CARBON CHEMICALS CORPORATION, Appellee

Appeal from the District Court of the United States for the District of Maryland

This Cause came on to be heard on the transcript of the record from the District Court of the United States for the District of Maryland, and was argued by counsel.

On Consideration Whereof, It is now here ordered, adjudged, and decreed by this Court that the decree of the said District Court, in this cause, be, and the same is hereby, affirmed with costs.

June 27, 1941.

Armistead M. Dobie, U. S. Circuit Judge.

July 22, 1941, petition of appellant for stay of mandate and for extension of time to present petition for rehearing is filed.

July 26, 1941, order extending time to August 27, 1941, within which to present petition for rehearing, and staying mandate, is filed.

August 19, 1941, petition of appellant for a rehearing is presented.

[fol. 192] ORDER DENYING REHEARING—Filed and Entered September 2, 1941

UNITED STATES CIRCUIT COURT OF APPEALS, FOURTH CIRCUIT

No. 4774

U. S. INDUSTRIAL CHEMICALS, INC., Appellant,

versus

CARBIDE AND CARBON CHEMICALS CORPORATION, Appellee

In the above entitled cause it is ordered that the petition for rehearing presented August 19, 1941, be and the same is hereby denied.

Sept. 1st, 1941.

John J. Parker, Senior Circuit Judge; Morris A. Soper, United States Circuit Judge; Armistead M. Dobie, United States Circuit Judge.

September 5, 1941, petition of appellant for a stay of the mandate is filed.

ORDER STAYING MANDATE—Filed September 8, 1941

[Style of Court and Title Omitted]

Upon the Application of the appellant, by its counsel, Dean S. Edmonds, and for good cause shown,

It Is Ordered that the mandate of this Court in the above entitled cause be, and the same is hereby, stayed pending the application of the said appellant in the Supreme Court of the United States for a writ of certiorari to this Court, unless otherwise ordered by this or the said Supreme Court, and provided said application is filed in the said Supreme Court within 30 days from this date.

September 6, 1941.

John J. Parker, Senior Circuit Judge.

[fol. 193] STIPULATION AS TO RECORD FOR USE IN SUPREME COURT ON APPLICATION FOR WRIT OF CERTIORARI—Filed September 16, 1941

UNITED STATES CIRCUIT COURT OF APPEALS, FOURTH CIRCUIT

No. 4774

U. S. INDUSTRIAL CHEMICALS, INC., Appellant,

vs.

CARBIDE AND CARBON CHEMICALS CORPORATION, Appellee

It is hereby stipulated by and between counsel for the respective parties hereto that the record to be certified by the Clerk of the Circuit Court of Appeals for use in the Supreme Court on the application for certiorari shall consist of the parts of the record contained in the appendix to the brief of the appellant and the appendix to the brief of the appellee, together with the proceedings in the Circuit Court of Appeals.

It is further stipulated that, in addition to the above transcript, the Clerk shall make up and send to the Supreme Court a complete transcript of the record for use in that court, if desired or required.

Dean S. Edmonds, Of Counsel for Appellant. L. A. Watson, Of Counsel for Appellee.

Dated: September 11, 1941.

[fol. 194] CLERK'S CERTIFICATE

UNITED STATES OF AMERICA,
Fourth Circuit, ss:

I, Claude M. Dean, Clerk of the United States Circuit Court of Appeals for the Fourth Circuit, do certify that the foregoing three (3) volumes is a true copy of the Supplement to Appellant's Brief; Appendix to Appellee's Brief, and of the proceedings in the said Circuit Court of Appeals in the therein entitled cause, as the same remain upon the records and files of the said Circuit Court of Appeals, and constitute and is a true transcript of the

record and proceedings in the said Circuit Court of Appeals in said cause, made up in accordance with the stipulation of counsel for use in the Supreme Court of the United States on an application for a writ of certiorari.

In Testimony Whereof, I hereto set my hand and affix the seal of the said United States Circuit Court of Appeals for the Fourth Circuit, at Richmond, Virginia, this 24th day of September, A. D., 1941.

Claude M. Dean, Clerk, U. S. Circuit Court of Appeals, Fourth Circuit. Seal.

[fol. 195] SUPREME COURT OF THE UNITED STATES

U. S. INDUSTRIAL CHEMICALS, INC., Petitioner,

vs.

CARBIDE AND CARBON CHEMICALS CORPORATION, Respondent

STIPULATION

It Is Hereby Stipulated By Counsel that the Petition for Certiorari may be considered on the appendices to the briefs of the parties as supplemented by the Circuit Court of Appeals proceedings.

It Is Further Stipulated that the original record be lodged with the Clerk and that in the event the Petition for Certiorari is granted counsel will then stipulate to print from the original record those parts which they deem pertinent.

Dean S. Edmonds, Counsel for Petitioner. L. A. Watson, Counsel for Respondent.

Dated: New York, N. Y., September 26, 1941.

[fol. 196] SUPREME COURT OF THE UNITED STATES

ORDER ALLOWING CERTIORARI—Filed November 10, 1941

The petition herein for a writ of certiorari to the United States Circuit Court of Appeals for the Fourth Circuit is granted.

And it is further ordered that the duly certified copy of the transcript of the proceedings below which accompanied the petition shall be treated as though filed in response to such writ.

[fol. 197] SUPREME COURT OF THE UNITED STATES

STIPULATION AS TO RECORD—Filed December 3, 1941

The petition for certiorari herein having been considered by the Court on the appendices to the briefs of the parties as filed in the Court of Appeals for the Fourth Circuit supplemented by the proceedings in the Court of Appeals, and the original record herein having been lodged with the Clerk of this Court, and the said petition for certiorari having been granted and the writ of certiorari issued,

It Is Hereby Stipulated by counsel that this case may be considered by the Court on the return of the writ of certiorari on the record as presented by the said appendices as filed by the parties in the Court of Appeals for the Fourth Circuit, and the physical exhibits there introduced.

Dan S. Edwards, Counsel for Petitioner. Leonard A. Watson, Counsel for Respondent.

Dated: New York, N. Y., December 1, 1941.

[fol. 198] [File endorsement omitted.]

FILED
OCT 4 1941
CHARLES ELMORE CROPLEY
CLERK

IN THE

Supreme Court of the United States

OCTOBER TERM, 1941

No. 680

U. S. INDUSTRIAL CHEMICALS, INC.,
Petitioner,

vs.

CARBIDE AND CARBON CHEMICALS CORPORATION,
Respondent.

PETITION FOR WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE FOURTH CIRCUIT AND BRIEF IN SUPPORT THEREOF

WILLIAM H. DAVIS,
Counsel for Petitioner.

THOMAS D. THACHER,
DEAN S. EDMONDS,
CHARLES W. RILEY,
W. PETERS BLANC,
Of Counsel.

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IN THE

Supreme Court of the United States

OCTOBER TERM, 1941

U. S. INDUSTRIAL CHEMICALS, INC.,
Petitioner,

vs.

CARBIDE AND CARBON CHEMICALS CORPORATION,
Respondent.

PETITION FOR WRIT OF CERTIORARI

To the Honorable, the Chief Justice and the Associate Justices of the Supreme Court of the United States:

Your petitioner, U. S. Industrial Chemicals, Inc., prays that a writ of certiorari issue to review the decree of the United States Circuit Court of Appeals for the Fourth Circuit entered herein on June 27, 1941 (R. 187).* Rehearing and reconsideration by that Court were requested and were denied September 2, 1941 (R. 188).

A certified transcript of the record in the case, including the proceedings in the Circuit Court of Appeals, is furnished herewith in compliance with Rule 38 of this Court.

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* All citations to the record in the petition and brief refer to the volume of the record entitled "Appendix to Plaintiff-Appellee's Brief".

Summary Statement of the Matter Involved

This is a suit in equity brought by respondent against petitioner in the United States District Court for the District of Maryland for alleged infringement of claims 8 and 9 of Reissue patent No. 20,370, granted May 18, 1937, on an application for reissue filed September 25, 1936. The reissue patent is founded upon original patent No. 1,998,878, for a "Process for the Production of Ethylene Oxide," granted April 23, 1935, on an application filed March 22, 1932.* The District Court held claims 8 and 9 of the reissue patent valid and infringed and entered the usual interlocutory decree. On appeal to the Circuit Court of Appeals for the Fourth Circuit, the decree was affirmed.

The invention described and claimed in the original patent is a process for the production of ethylene oxide which consists in subjecting ethylene to the action of *oxygen* (which can be the oxygen of air) *and water* (either in the liquid state or as steam) in the presence of certain named catalysts placed in a reaction tube or chamber in which the temperature is maintained within a specified range. *The process described and claimed is one in which the introduction of water into the reaction chamber is mandatory, the introduction of water being described, not as an optional procedure, but as an essential step in the process, always to be taken.*

The present suit is based upon claims 8 and 9 of the reissue patent. These are entirely new claims added by the reissue to the seven claims of the original patent. The original seven claims are retained, in substantially the same

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* Copies of the original and reissue patents may be found at pages 283 and 277 of the "Supplement to Defendant-Appellant's Brief."

form, as claims 1 to 7 inclusive of the reissue. They are not charged to be infringed by petitioner's process.

Claims 8 and 9 are of broader scope than the claims of the original patent in that they cover not only a process in which water is voluntarily introduced into the reaction chamber, but also *a process in which the voluntary introduction of water into the reaction chamber is omitted.* This is the interpretation placed upon claims 8 and 9 of the reissue by respondent and accepted by the trial judge and by the Court of Appeals. It is the interpretation they must bear to sustain the charge of infringement.*

Petitioner is engaged in the commercial production of ethylene glycol in its manufacturing plant at Baltimore, Maryland. As one of the steps in such manufacture, ethylene oxide is produced by a process which includes passing a mixture of ethylene and atmospheric air through a reaction chamber containing a catalyst and maintained at a suitable high temperature. *The process employed by petitioner does not include the voluntary introduction of water into the reaction chamber.* Thus petitioner's accused process is not the process described and claimed in the original patent. It is not the process covered by claims 1 to 7 of the reissue patent. It is covered by the broader claims 8 and 9 of the reissue patent and infringes those claims if they are valid.

Petitioner challenged the validity of claims 8 and 9 of the reissue patent upon several grounds including the defense that those two claims are not "for the same invention" as the original patent within the meaning of the

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* The Court below uses the expression "voluntary introduction of water" to distinguish the step of introducing water to the chamber from an outside source from the mere formation of water as a by-product during the course of the reaction in the reaction chamber.

Reissue Statute, R. S. 4916.* Petitioner also maintained that respondent is estopped from asserting claims 8 and 9 of the reissue against petitioner, even if those claims are valid, because of intervening rights acquired by petitioner with respect to the accused process prior to the issuance of the reissue patent.

In its decision sustaining the validity of claims 8 and 9 of the reissue, the Court of Appeals stated that it regarded the issue whether those claims are for "the same invention" within the meaning of the reissue statute as "the vital question involved" (R. 183). It found that "there is a difference" between the process described and claimed in the original patent and the process embraced by claims 8 and 9 of the reissue. It found that "difference" to be that whereas the original patent describes and claims a process in which the voluntary introduction of water into the reaction chamber is regarded as an essential step always to be taken, the reissue patent describes, and claims 8 and 9 thereof cover, a process in which, as in petitioner's accused process, the desired result is obtained without the voluntary introduction of water into the reaction chamber. Notwithstanding such findings, the Court held that the claims in question are for "the same invention" within the meaning of the reissue statute and upheld their validity.

In rejecting the defense of intervening rights, the Court of Appeals rested its conclusion upon the view that the doctrine of intervening rights is inapplicable in the instant case because a relatively larger proportion of the activities and expenditures of petitioner in connection with ethylene oxide, including all commercial use of its process, occurred after instead of before the grant of the reissue patent.

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* The full text of Section 4916 R. S. will be found as an Appendix, page 31.

Questions Presented

The questions presented by the case are the following:

(1) Can a patent for a process which includes a step asserted to be mandatory and described and claimed in the original patent as an essential feature of the invention be reissued to include a process which achieves the same result while dispensing with the step in question?

(2) Does one who in good faith and at great expense completely developed a process which does not infringe an original patent but does infringe the broadened claims of a reissue granted after the development work is complete but before the new process is put into commercial use, acquire intervening rights barring injunctive relief against continued use of the process?

Reasons for Granting the Writ

(1) There is a direct conflict between the interpretation placed upon the statutory requirement that a reissue patent must be "for the same invention" (R. S. 4916, U. S. Code, Title 35, Sec. 64) by the Circuit Court of Appeals in sustaining the validity of claims 8 and 9 of the reissue patent, and the interpretation placed upon that requirement by this Court.

Gill v. *Wells*, 22 Wall. 1;
Russell v. *Dodge*, 93 U. S. 460;
Manufacturing Co. v. *Ladd*, 102 U. S. 408;
James v. *Campbell*, 104 U. S. 356, 375;
Johnson v. *Railroad Co.*, 105 U. S. 539;
McMurray v. *Mallory*, 111 U. S. 97;
Parker & Whipple Co. v. *Yale Clock Co.*, 123 U. S. 87;

Hoskin v. *Fisher*, 125 U. S. 217, 222;
Cornell v. *Weidner*, 127 U. S. 261, 264;
Flower v. *Detroit*, 127 U. S. 563;
Huber v. *Nelson Mfg. Co.*, 148 U. S. 270;
Corbin Cabinet Lock Co. v. *Eagle Lock Co.*, 150 U. S. 38;
Olin v. *Timken*, 155 U. S. 141, 147.

(2) There is a direct conflict between the interpretation placed upon the statutory requirement that a reissue must be "for the same invention" by the Circuit Court of Appeals for the Fourth Circuit in sustaining the validity of claims 8 and 9 of the reissue patent, and the interpretation placed upon that requirement by the Courts of Appeals for the Second, Third, Seventh and Eighth Circuits and by the Court of Customs and Patent Appeals.

Featherstone v. *George R. Bidwell Cycle Co.*, 57 Fed. 631 (C. C. A., 2d);
Toupet-Taylor Engineering Co. v. *Red Dog Mfg. & Supply Co.*, 16 F. (2d) 454 (C. C. A., 3d);
Chicago Ry. & Equipment Co. v. *Perry Side Bearing Co.*, 170 Fed. 968 and 178 Fed. 449 (C. C. A., 7th);
McDowell v. *Ideal Concrete Mach. Co.*, 187 Fed. 814 (C. C. A., 7th);
Penn Electric Switch Co. v. *Luthe Hardware Co.*, 63 F. (2d) 842 (C. C. A., 8th);
Morgan v. *Drake*, 36 F. (2d) 511 (C. C. P. A.);
In re Cogswell, 48 F. (2d) 402 (C. C. P. A.);
In re Williams, 75 F. (2d) 520 (C. C. P. A.);
Kollsman v. *Carbonara*, 88 F. (2d) 966 (C. C. P. A.);
In re French, 89 F. (2d) 662 (C. C. P. A.);
In re Overbury, 95 F. (2d) 331 (C. C. P. A.).

(3) In denying petitioner's claim of intervening rights, the Court of Appeals has rendered a decision in direct conflict with the decision of the Court of Appeals for the Second Circuit on the same matter in *Otis Elevator Co.* v. *Atlantic Elevator Co.*, 47 F. (2d) 545. The question of intervening rights involved in this conflict of decision is an important question of patent law, heretofore recognized as such by this Court, which has not been but should be determined by the Court.

(4) Claims 8 and 9 of the reissue patent cover a process of unquestioned commercial value; the validity of these claims is at least doubtful; and further litigation presenting the possibility of a conflict of decision is improbable (a) because petitioner is the only concern, except respondent, which has used the process up to the present time, and (b) because the investment required to construct and equip a plant capable of practicing the process profitably is so great that no prudent person or company would undertake to risk such an investment knowing that it would involve infringement of a patent which had been sustained by a Court of Appeals.

WHEREFORE it is respectfully submitted that this petition for a writ of certiorari to the Circuit Court of Appeals for the Fourth Circuit should be granted.

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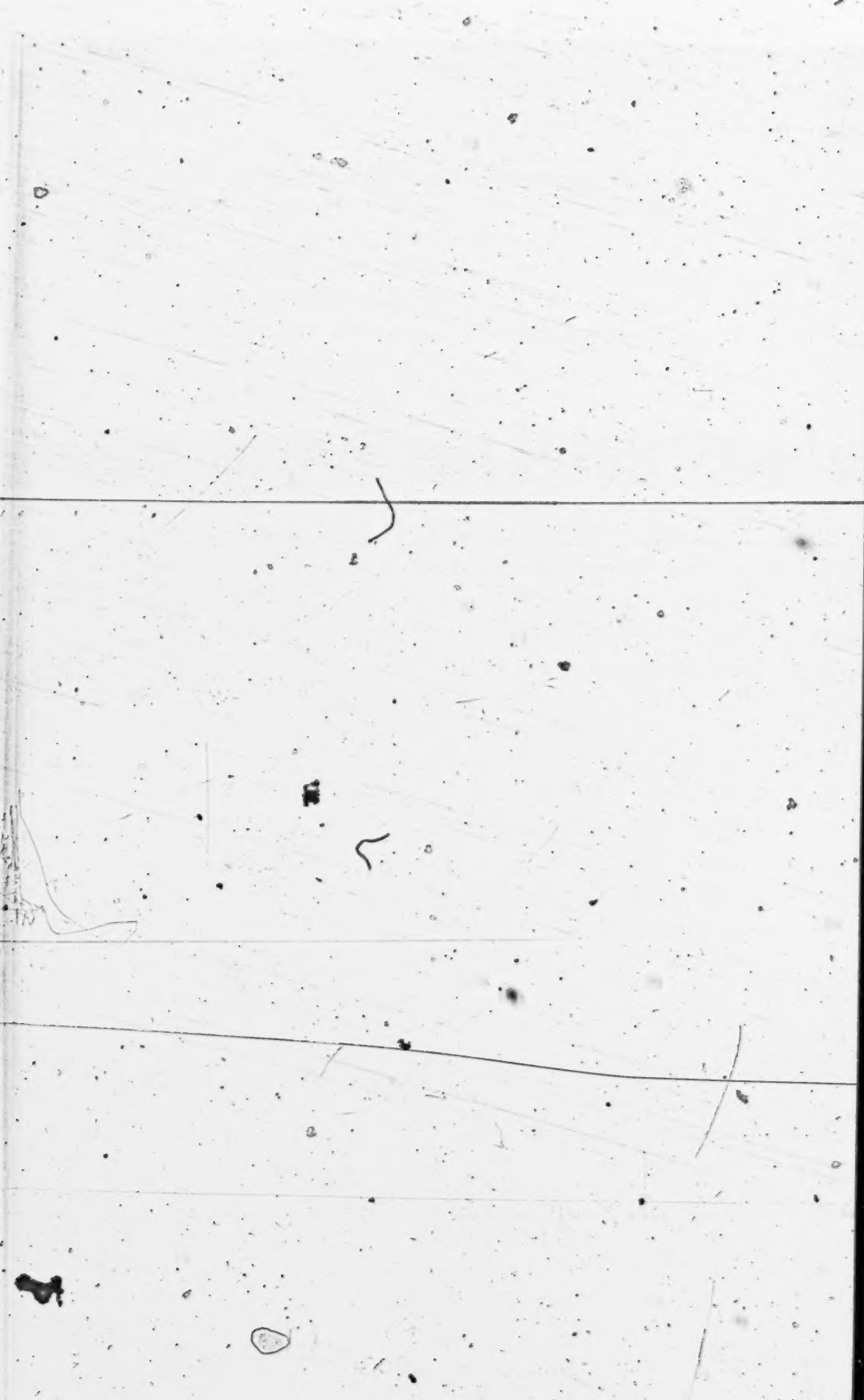
Of Counsel.

Dated: New York, N. Y., October 3, 1941.



BRIEF IN SUPPORT OF PETITION FOR WRIT OF CERTIORARI

Opinions of the Courts Below

The opinion of the United States District Court for the District of Maryland is reported in 34 F. Supp. 813.* The opinion of the Circuit Court of Appeals for the Fourth Circuit appears at page 173 of the record and is reported in 121 F. (2d) 665.

Jurisdiction

The jurisdiction of this Court is invoked under Section 240(a) of the Judicial Code as amended by the Act of February 13, 1925, c. 229 (28 U. S. Code, Sec. 347). The decree of the Circuit Court of Appeals for the Fourth Circuit, which petitioner seeks to have reviewed was entered June 27, 1941 (R. 187).

Statement of the Case

The essential facts of the case are stated in the accompanying petition for a writ of certiorari.

Specification of Errors

The errors which petitioner will urge if the writ of certiorari is issued, are that the Circuit Court of Appeals for the Fourth Circuit erred:

* See also "Supplement to Defendant-Appellant's Brief" page 3.

1. In holding that claims 8 and 9 of the reissue patent in suit are for the same invention as the original patent.

2. In holding that injunctive relief against continued use of the process was not barred by petitioner's intervening rights.

Summary of Argument

The points of argument will follow the reasons relied upon for allowance of the writ of certiorari.

ARGUMENT

I.

There is a direct conflict between the interpretation placed upon the statutory requirement that a reissue must be "for the same invention" by the Circuit Court of Appeals in sustaining the validity of claims 8 and 9 of the reissue patent, and the interpretation placed upon that requirement by this Court and by the Courts of Appeals for the Second, Third, Seventh and Eighth Circuits.

The reissue statute, by its terms, limits the authority of the Commissioner of Patents to the reissuing of a patent *"for the same invention"* as that patented by the original patent. The statute emphasizes this requirement by providing that "no new matter shall be introduced into the specification" of the reissue. The authority granted by the statute being thus limited, a reissue patent is invalid where it appears that the reissue is not *"for the same invention."* *Seymour* v. *Osborne,* 11 Wall. 516, 544-6;

Powder Co. v. *Powder Works*, 98 U. S. 126; *Mahn* v. *Harwood*, 112 U. S. 354, 359.

The requirement that a reissue patent must be "for the same invention" has been in all the reissue statutes,* and the phrase, as it has appeared in the various statutes, has been before this Court for interpretation in numerous cases.

This Court has determined that the requirement that a reissue patent must be "for the same invention" does not mean that the subject matter *claimed* in the reissue must be identical with that *claimed* in the original patent; a reissue may properly contain a narrower claim than the original (*Miller* v. *Brass Co.*, 104 U. S. 350, 353), or a broader claim (*Topliff* v. *Topliff*, 145 U. S. 156). On the other hand, it has been determined by this Court that a reissue is not "for the same invention" merely because the additional matter covered by the reissue was within the knowledge of the patentee at the date of application for his original patent (*Powder Co.* v. *Powder Works*, 98 U. S. 126, 138; *Manufacturing Co.* v. *Ladd*, 102 U. S. 408, 413; *Huber* v. *Nelson Mfg. Co.*, 148 U. S. 270), or merely because the additional matter covered by the reissue was an invention which might have been claimed in the original patent because it was suggested or indicated in the specification (*Parker & Whipple Co.* v. *Yale Clock Co.*, 123 U. S. 87, 99; *Flower* v. *Detroit*, 127 U. S. 563, 571).

The whole subject of the interpretation of the phrase "for the same invention" was reviewed and settled by this Court in *Parker & Whipple Co.* v. *Yale Clock Co.*, 123 U. S.

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* See *Parker & Whipple Co.* v. *Yale Clock Co.*, 123 U. S. 87, 96-7.

And this conclusion was fortified and reiterated as follows (R. 176):

> "Some study of chemical history and literature, as these existed at the time of Lefort's labors, convinces us even more strongly of the truth of the conclusion that the voluntary introduction of water was a mandatory provision of the original Lefort patent."

By contrast, the Court defined the process which the claims of the reissue patent are intended to cover, as follows (R. 176):

> "It seems quite clear, on the other hand, that the reissue patent does *not* contemplate the voluntary introduction of water into the reaction-chamber as a necessary step in the procedure." (Emphasis by the Court.)

In summarizing the findings resulting from this comparison of the two patents, the Court said (R. 177):

> "We have just held that *there is a difference* here in that the original patent contemplated the voluntary introduction of water in the reaction-chamber (distinguished from the mere formation of water during the course of the reactions) as a step that would always be taken in the procedure therein set out, while Claims #8 and #9 contain no such requirement, and indeed seem to negative clearly any such step." (Emphasis and parenthesis by the Court.)

Had the lower Court applied at this point this Court's interpretation of the statutory requirement that a reissue be "for the same invention" it would have concluded that the reissue patent was invalid.

Instead, the Court of Appeals proceeded to consider whether the difference it had found to exist between the process embodied in the original patent as the invention intended to be secured by it and the process covered by claims 8 and 9 of the reissue patent was "vital, essential, substantial, material," not from the point of view of the monopoly sought by the patentee in his original patent and obtained by him in his reissue patent, but from a purely scientific point of view. The Court resolved the issue thus created in favor of the respondent and thereupon held the reissue patent valid.

The basis asserted by the lower Court for this decision was the conclusion of respondent's expert witnesses that the difference between the two processes is not significant from a scientific point of view since the same practical result can be obtained whether the method followed is that of the process disclosed in the original patent or that of the process disclosed and claimed in the reissued patent.* Relying on this evidence, the lower Court concluded that the two patents are for the same invention and sustained the reissue. In thus grounding its decision upon an evaluation of the difference between the process of the original patent and the process of the reissued patent in its purely technological aspect, the lower Court departed from the rule of this Court that the intention of the patentee as it appears from the original patent is controlling.

The failure to accept this Court's interpretation of the statute led the lower Court into direct conflict with a

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* The experts' testimony was characterized as being "from the technical viewpoint of chemistry," "from a scientific standpoint", or "speaking entirely as a chemist." (See Court of Appeals' opinion, R. 180-1.)

group of decisions by this Court applying the principle of *Parker & Whipple* v. *Yale Clock Co.* to situations of identically the same nature as that presented here in which a patentee has attempted by reissue to make permissive a step described as mandatory in his original patent. Without exception these cases hold that the statutory requirement that a reissue must be "for the same invention" does not permit any step of a process, or any element of a device, made essential in an original patent to be made non-essential in a reissue.

In the case of *Russell* v. *Dodge*, 93 U. S. 460, the original patent was for a process of treating bark-tanned skins by means of a compound in which *heated* fat liquor was explicitly made an essential ingredient. In the reissue, the specification was changed by eliminating the requirement that the fat liquor be in a heated condition. The Court held the reissue invalid, saying (p. 464):

> "The change made in the old specification, by eliminating the necessity of using the fat liquor in a heated condition, and making in the new specification its use in that condition a mere matter of convenience, and the insertion of an independent claim for the use of fat liquor in the treatment of leather generally, operated to enlarge the character and scope of the invention. The evident object of the patentee in seeking a reissue was not to correct any defects in specification or claim, but to change both, and thus obtain, in fact, a patent for a different invention. This result the law, as we have seen, does not permit.
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> * * * To determine the identity of the invention, the two patents may be compared. Thus compared, the reissue here appears on its face to be for a different invention, and the commissioner, therefore,

> exceeded his authority in issuing it. *Seymour* v. *Osborn*, 11 Wall. 544; *Wicks* v. *Stevens*, 2 Woods 312."

The same rule has been applied to patents for apparatus. In the case of *Huber* v. *Nelson Mfg. Co.*, 148 U. S. 270, the patent was for a flushing apparatus consisting of a combination of various elements including a flushing chamber. In the specification of the original patent, the flushing chamber had been made an essential element both in the description and the claims. The reissue included claims for the same combination except for the omission of the flushing chamber. The Court held the reissue patent invalid, saying (p. 291):

> "The entire text of the original specification shows nothing but the invention of a structure containing both a tank and a flushing-chamber. That chamber is referred to in the text of the original specification thirty-one times.
>
> We think that, on all the facts of this case, no one of the claims of the reissue can be construed as valid in leaving out the flushing-chamber as an element of the combination, inasmuch as every claim of the original patent contained it. *Prouty* v. *Ruggles*, 16 Pet. 336, 341; *Brookes* v. *Fiske*, 15 How. 212, 219; *Burr* v. *Duryee*, 1 Wall. 531; *Reckendorfer* v. *Faber*, 92 U. S. 347; *Fuller* v. *Yentzer*, 94 U. S. 288; *Railway Co.* v. *Sayles*, 97 U. S. 554; *Water-Meter Co.* v. *Desper*, 101 U. S. 332."

Numerous other cases in this Court present analogous situations resulting in a decision of invalidity. Examination of these cases discloses that the question of intention always governs and that the technological result of the

reissued process or apparatus, whether it be the same, better or worse, is immaterial to the decision.*

The lower Court assumed to find support for its decision in the case of *Seymour* v. *Osborne*, 11 Wall. 516 (R. 182). That case approves resort to the testimony of expert witnesses when the Court is determining, as a matter of construction by comparison of the two instruments, whether the original and reissue patents are for the same invention. Such resort is approved for explanation of technical terms or terms of art in ascertaining the true meaning of the language employed. The Circuit Court of Appeals in the instant case did resort to the testimony of expert witnesses for that purpose (R. 176), and having done so, found without any hesitation that "*there is a difference* here in that the original patent contemplated the voluntary introduction of water into the reaction-chamber (distinguished from the mere formation of water during the course of the reactions) as a step that would always be taken in the procedure therein set out, while Claims #8 and #9 contain no such requirement, and indeed seem to negative clearly any such step."

The decision of this Court in *Seymour* v. *Osborne*, created no alteration in the established rule of this Court as to the proper interpretation of the words "for the same

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* *Gill* v. *Wells*, 22 Wall. 1; *Manufacturing Co.* v. *Ladd*, 102 U. S. 408; *James* v. *Campbell*, 104 U. S. 356, 375; *Johnson* v. *Railroad Co.*, 105 U. S. 539; *McMurray* v. *Mallory*, 111 U. S. 97; *Hoskin* v. *Fisher*, 125 U. S. 217, 222; *Cornell* v. *Weidner*, 127 U. S. 261, 264; *Corbin Cabinet Lock Co.* v. *Eagle Lock Co.*, 150 U. S. 38; *Olin* v. *Timken*, 155 U. S. 141, 147.

invention" in the reissue statute.* That case does not in any way support the action of the Circuit Court of Appeals in the instant case in sustaining a reissue patent which, on the facts found by the Court, differs essentially from the original patent in respect to the scope of its asserted monopoly, merely because, in the opinion of the Circuit Court of Appeals, it has been established by expert testimony that the limitation to the voluntary addition of water is not in fact essential to obtaining the desired result.

In the final section of the opinion of the lower Court entitled "General Considerations", the Court asserts that the defenses set up by petitioner, including this defense that the reissue patent is not for the same invention as the original patent, are "terribly technical in the extreme" and "contain little or no appeal to the beneficent principles of equity and good conscience".

We submit that exactly the contrary is true. The rule so long established and so consistently observed by this Court finds its origin in a determination to protect from abuse the beneficent purposes of the reissue statute; to preserve to the patentee who has by inadvertence, accident or mistake, obtained a patent that is inoperative or insufficient to cover what he intended to claim as his invention, the right to correct his mistake by subsequent reissue, while at the same time guarding against any abuse of that privilege by which the monopoly originally contemplated is artificially enlarged to embrace subsequent developments, thereby subjecting industry to hidden liens and unknown liability to vexatious lawsuits. The reissue statute is a

* See this Court's comment on *Seymour* v. *Osborne* in *Parker & Whipple Co.* v. *Yale Clock Co.*, 123 U. S. 87 at p. 97.

remedial and permissive statute. It extends to the patentee the unusual privilege of modifying his contract with the public to correct bona fide mistakes which have caused his assertion of monopoly to fall short of what he intended to claim. The requirement of the statute that the reissue be "for the same invention" is a fundamental statutory limitation upon this privilege, intended and well adapted, as it has been interpreted by this Court, to prevent abuse of the privilege. It is this restriction that separates the good from the bad, allowing the just claims of the inventor who has failed by inadvertence, accident or mistake to secure his intended monopoly, while barring the unjust claims of a patentee who seeks to extend his monopoly to cover subsequent discoveries, improvements, or developments of others which were not within his knowledge at the date of his application or which he failed to disclose to the public by assertion in his original patent.* That statutory limitation and its interpretation have most assuredly appealed to the "equity and good conscience" of this Court over a long period of years.

The Court below, on the basis of the considerations which it has set forth in its opinion and which we have discussed, has seen fit to attempt a breach in the well-established rule; to open therethrough a passage toward what the Court believed to be equity and good conscience, on evidence that in a scientific sense the newly monopolized process of the broadened claims is not different vitally,

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*Although respondent had full opportunity in the course of the trial, it failed to produce any evidence that Lefort ever knew that the process disclosed in the original patent was operative with the water step eliminated prior to his application for reissue. Petitioner made this discovery by its own independent efforts (*infra*, p. 24).

essentially, substantially or materially from the process monopolized by the original claims, because the new process produces the same technical result as the old. We submit that through such a breach all of the evils which this Court has tried to shut out would pour. It is precisely because industry must remain free to produce by other processes the technical results of a patented process, that the rule has been adopted and enforced.

Conflict with other Courts of Appeals

This Court has not had occasion to pass on any case involving interpretation of the "same invention" requirement of the reissue statute since *Olin* v. *Timken*, decided in 1894 (155 U. S. 141). Since that time, the question has been considered in numerous Court of Appeals' decisions. The interpretation placed upon this requirement of the statute by the Courts of Appeals for the Second, Third, Seventh and Eighth Circuits, and also by the Court of Customs and Patent Appeals, has followed the interpretation adopted by this Court, namely, that to satisfy the requirement of the statute it must appear from a comparison of the two patents that the original patent embodied, as the invention intended or sought to be covered or secured by it, what the claims of the reissue are intended to cover.

That this interpretation has been placed upon the statute by these Courts is shown by the following representative cases:

Featherstone v. *George R. Bidwell Cycle Co.*, 57 Fed. 631 (C. C. A. 2nd);

Toupet-Taylor Engineering Co. v. *Red Dog Mfg. & Supply Co.*, 16 F. (2d) 454 (C. C. A. 3rd);

Chicago Ry. & Equipment Co. v. *Perry Side Bearing Co.*, 170 Fed. 968 and 178 Fed. 449 (C. C. A. 7th);
McDowell v. *Ideal Concrete Mach. Co.*, 187 Fed. 814 (C. C. A. 7th);
Penn Electric Switch Co. v. *Luthe Hardware Co.*, 63 F. (2d) 842 (C. C. A., 8th);
Morgan v. *Drake*, 36 F. (2d) 511 (C. C. P. A.);
Kollsman v. *Carbonara*, 88 F. (2d) 966 (C. C. P. A.);
In Re Cogswell, 48 F. (2d) 402 (C. C. P. A.);
In Re Williams, 75 F. (2d) 520 (C. C. P. A.);
In Re French, 89 F. (2d) 662 (C. C. P. A.);
In Re Overbury, 95 F. (2d) 331 (C. C. P. A.).

That this conflict is one of decision and not merely one of verbiage is well illustrated by the decision of the Second Circuit Court of Appeals in the *Featherstone* case cited above. That case involved a reissue patent for a bicycle tire. In the specification and claims of the original patent certain "protective strips" were regarded as an essential part of the invention. In the reissue patent the claims were freed of this limitation. In considering the technological aspect of these strips the Court said (pp. 634-35):

> "It is obvious that the protective strips which are incorporated into the claim of the original patent, but which are omitted in the fourth claim of the reissue, are not an indispensable part of operative fastening devices for securing a pneumatic tire to the rim of the wheel. It is also obvious that they can be omitted from the fastening devices of Dunlop without rendering the other devices inoperative."

In spite of this finding that the strips were not a "vital, essential, substantial, material" element of the invention

from a scientific point of view, the Court held the reissue patent invalid, saying (p. 636):

> "It has been repeatedly declared by the Supreme Court that a reissue cannot be permitted to secure any invention which was not described in the original patent; it is confined to securing one which was not only described, but which it was the intention of the patentee, manifest upon the face of the patent itself, to secure thereby. In other words, it must appear by the description in the original patent that it was the purpose of the patentee to secure the thing specified in the claim of the reissue, and a patent cannot be lawfully reissued unless there has been a clear mistake, inadvertently committed, in the wording of the claim."

This clear conflict with the above decision of the Second Circuit Court of Appeals, and with decisions of similar import in other Courts of Appeals, emphasizes and reinforces what we have already said as to the evil effects that will follow if the conflict created by the instant decision of the Fourth Circuit Court of Appeals be left unresolved.

II.

There is direct conflict between the decision of the Circuit Court of Appeals in the instant case denying petitioner's claim of intervening rights, and the decision of the Second Circuit Court of Appeals. This is a conflict on an important question of patent law which has not been but should be resolved by this Court.

As we have already pointed out, petitioner's accused process is one that does not include the voluntary introduction of water into the reaction chamber, and for that

reason was not covered by the seven claims of the original patent, but only by the newly added claims 8 and 9 of the reissue patent.

Petitioner's process was independently developed as the result of research and engineering work begun early in 1936, nearly a year after the original patent had issued and several months before the application for reissue was filed. The idea of introducing water into the reaction chamber was laid aside from the start. The total of the expenditures of petitioner upon the development work from its inception to May 18, 1937, the date upon which the reissue patent was granted, was approximately $150,000. The development of petitioner's process was completed by May 8, 1937, a date earlier than the date upon which the reissue patent was granted. There followed work for the construction of a commercial plant which was not completed and put into operation until May 9, 1939.

One of the questions before the lower Court was whether petitioner had, by reason of the facts recited above, acquired such intervening rights as would render it inequitable to enforce against it the enlarged monopoly of claims 8 and 9 of the reissue. The Court held that these facts did not establish intervening rights in favor of petitioner, basing its decision upon the ground that the expenditures and labor which preceded the grant of reissue were largely for experimental purposes and stressing the fact that the $150,000 so expended was a small sum in comparison with the sums thereafter invested in building a commercial plant.

The question of intervening rights in connection with reissued patents was recognized by this Court as being an important question of patent law which had not been but

should be determined by this Court in *Keller* v. *Adams-Campbell Co.*, 264 U. S. 314, but no decision on the issue of intervening rights was rendered in that case. Quite recently the issue of intervening rights came before this Court again in *Sontag Chain Stores Co.* v. *National Nut Co.*, 310 U. S. 281. In that case, this Court decided that when it appears that the defendant in a suit for infringement of a reissued patent began commercial use of the accused process or machine prior to the application for the reissued patent, then intervening rights accrue to him and injunctive relief against him should be denied the patent owner. The decision in that case was specifically limited to the scope indicated. Being so limited, it left undecided by this Court whether or not intervening rights accrue to one who fully and completely develops a process or apparatus by prolonged and expensive research carried on prior to the grant of reissue, but does not go into commercial operation until after the grant of the reissue. This question has never been decided by this Court.

In the case of *Otis Elevator Company* v. *Atlantic Elevator Company*, 47 F. (2d) 545, which the Fourth Circuit Court of Appeals in the instant case said is "clearly distinguishable on the facts" without pointing out any distinction, the Second Circuit Court of Appeals considered and discussed the effect of development work in an interim period of more than two years between the date of an original patent and the application date of a broadened reissue patent, and with respect to the situation presented to it stated (p. 548):

> "The installations at Los Angeles, Chicago and Pittsburgh were, it is true, experiments, and did not go into permanent operation, but they were steps

forward. They involved considerable expense, whose fruition came later in the building at Cleveland, completed before the application was filed. We should not ignore them, because they were not used; the analogy of a prior use as anticipation is not apt. The question, on any view, is of the conflicting interests involved; the patentee's, to extend his monopoly; the public's, to be protected in vested rights acquired meanwhile. Earlier experiments, involving large expense, and being the first steps in a continuous development which ends in a completed apparatus, are fairly to be taken as vested interests. Unless we are to admit nothing except what the infringer himself may do, the case is one for the doctrine of intervening rights. The art by successive steps had already occupied the area comprehended by the expansion of the reissued claims."

The Court also declared: "the critical date should certainly be that of the reissue itself, not of the application, since the application is not published" (p. 549).

In the case at Bar the interim period between the date of the original patent and the date of the broadened reissue patent was also more than two years. Consequently a direct conflict exists between Courts of Appeals with reference to the availability of experimental or development work in establishing the defense of intervening rights.

The question is one of importance, particularly affecting those industries where extensive development work of an experimental nature involving years of time and large expenditures of money necessarily precedes commercial operation. The conclusion reached by the Fourth Circuit Court of Appeals in the instant case means, in practice, that the tremendous modern investment in research and development of improved industrial processes, upon which the

progress of modern industry so largely depends, will not be protected under the equitable doctrine of intervening rights.

We have here, therefore, a conflict on an important branch of the patent law which this Court recognized as unsettled in the *Keller* case and disposed of only in part in the *Sontag* case and which requires the attention of this Court.

III.

Further litigation presenting the possibility of conflict is highly improbable because these litigants are the only manufacturers now using the patented process and the cost of equipping for operation is so great.

This Court has granted certiorari in patent cases on occasions in the past where it appeared that notwithstanding the doubtful validity of the patent in suit further litigation resulting in conflict of decision as to the validity of the patent was improbable. In *Schriber-Schroth Co.* v. *Cleveland Trust Co. et al.*, 305 U. S. 47, 50, *Paramount Publix Corp.* v. *American Tri-Ergon Corp.*, 294 U. S. 464, and *Altoona Publix Theatre* v. *American Tri-Ergon Corp.*, 294 U. S. 477, certiorari was granted because the concentration of the industry in the circuit in which the patent had been sustained rendered it doubtful that any infringement suit would be instituted elsewhere. In *Mackay Radio & Telegraph Co.* v. *Radio Corporation of America*, 306 U. S. 86, 89, the Court granted certiorari because it appeared that the petitioner and the respondent represented substantially the entire industry so that further litigation resulting in conflict of decision among circuits was improbable.

The facts of the instant case present the same occasion for the grant of certiorari as was presented in those four cases and recognized by this Court as making it appropriate and expedient to issue the requested writ. They differ from the facts of those four cases only in details.

The Court of Appeals has recognized that the patent is of doubtful validity, stating with respect to what it characterized as "the vital question involved";

> "The question of substantial variance * * * is close and troublesome * * *."

At the present time there is no manufacturer, other than the parties to this litigation, engaged in producing ethylene oxide by any process which can be considered within the scope of the reissue patent. A plant for the commercial production of ethylene oxide by such processes is large, intricate and costly. Its cost would be more than one-half million dollars and probably as much as or more than three-quarters of a million dollars, and conversion of an existing plant would be equally costly. The affidavits annexed hereto establish these facts.*

In view of the very substantial investment required for a plant for the production of ethylene oxide by direct oxidation and the decision of the Court of Appeals for the Fourth Circuit sustaining the reissue patent, the possibility that any other manufacturer will enter into the production of ethylene oxide by any process which might be considered within the scope of the reissue patent is extremely remote, despite the commercial importance of ethylene oxide and products derived therefrom, and despite the recognized doubt as to the validity of the patent. There can be no reasonable expectation that anyone will make the large

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* Infra, page 32.

investment required with knowledge that he is almost certain to be sued for infringement of a patent which has been sustained by a Court of Appeals. Hence, further litigation involving the validity of the patent is highly improbable.

The industry is thus effectually bound by the decision of the Circuit Court of Appeals for the Fourth Circuit to respect a patent of doubtful validity without hope of ever having that patent subjected to the corrective process of review and consideration in other circuits. We submit that these facts warrant the grant of a writ of certiorari in this case, just as analogous facts warranted the grant of writs in the *Schriber-Schroth, Paramount Publix, Altoona Publix,* and *Mackay Radio* cases.

Conclusion

It is urged, therefore, that the petition for writ of certiorari be granted.

Respectfully submitted,

WILLIAM H. DAVIS,
Counsel for Petitioner.

THOMAS D. THACHER,
DEAN S. EDMONDS,
CHARLES W. RILEY,
W. PETERS BLANC,
Of Counsel.

Dated: New York, N. Y., October 3, 1941.

APPENDIX

Reissue Statute

R. S., SEC. 4916. (U. S. C., Title 35, Sec. 64.) Whenever any patent is wholly or partially inoperative or invalid, by reason of a defective or insufficient specification, or by reason of the patentee claiming as his own invention or discovery more than he had a right to claim as new, if the error has arisen by inadvertence, accident, or mistake, and without any fraudulent or deceptive intention, the commissioner shall, on the surrender of such patent and the payment of the duty required by law, cause a patent for the same invention, and in accordance with the corrected specification, to be reissued to the patentee or to his assigns or legal representatives, for the unexpired part of the term of the original patent. Such surrender shall take effect upon the issue of the reissued patent, but in so far as the claims of the original and reissued patents are identical, such surrender shall not affect any action then pending nor abate any cause of action then existing, and the reissued patent to the extent that its claims are identical with the original patent shall constitute a continuation thereof and have effect continuously from the date of the original patent. The commissioner may, in his discretion, cause several patents to be issued for distinct and separate parts of the thing patented, upon demand of the applicant, and upon payment of the required fee for a reissue for each of such reissued letters patent. The specifications and claims in every such case shall be subject to revision and restriction in the same manner as original applications are. Every patent so reissued, together with the corrected specifications, shall have the same effect and operation in law, on the trial of all actions for causes thereafter arising, as if

the same had been originally filed in such corrected form; but no new matter shall be introduced into the specification, nor in the case of a machine patent shall the model or drawings be amended, except each by the other; but when there is neither model nor drawing, amendments may be made upon proof satisfactory to the commissioner that such new matter or amendment was a part of the original invention, and was omitted from the specification by inadvertence, accident, or mistake, as aforesaid.

Affidavit of Floyd J. Metzger

SUPREME COURT OF THE UNITED STATES

U. S. INDUSTRIAL CHEMICALS, INC.,
Petitioner,

vs.

CARBIDE AND CARBON CHEMICALS CORPORATION,
Respondent.

AFFIDAVIT

STATE OF NEW YORK }
COUNTY OF NEW YORK } ss.:

FLOYD J. METZGER, being first duly sworn, deposes and says as follows:

My name is Floyd J. Metzger. I am a citizen of the United States. I reside in New York City and have resided in New York City for upwards of twenty-five years.

I am and for nearly twenty years past have been Vice-President of Air Reduction Company and for nearly twenty-five years have been in charge of the research and development work of that company. For upwards of ten years last past Air Reduction Company has owned a large stock interest in U. S. Industrial Alcohol Company of which U. S. Industrial Chemicals, Inc., petitioner in this suit is a wholly-owned subsidiary. One result of that is that I am and for many years past have been in charge of research and development work for U. S. Industrial Chemicals, Inc., and U. S. Industrial Alcohol Company.

I have had charge of the laboratory at Stamford, Connecticut, in which was developed the process of oxidation of ethylene to produce ethylene oxide, which process is employed in commercial production at the plant of U. S. Industrial Chemicals, Inc., at Baltimore, Maryland. It is that process which is charged to infringe claims 8 and 9 of the Lefort Reissue patent #20,370 in the above entitled suit. I am and for many years past have been familiar with the methods employed in the United States in the production of ethylene oxide and the manufacturers who are and have been engaged in the production of ethylene oxide and related products.

Based upon knowledge so acquired by me, I state it to be a fact that the plaintiff in this suit and respondent in this Court, Carbide and Carbon Chemicals Corporation, and the defendant in the suit and petitioner in this Court, U. S. Industrial Chemicals, Inc., are the only manufacturers in the United States who are or at any time in the past have been engaged in the production of ethylene oxide by a process of direct oxidation of ethylene. Ethylene oxide is and for many years past has been produced commercially in the United States by another method, sometimes referred

to generally as indirect oxidation and more often as the chlorhydrin process.

I am intimately familiar with the process of direct oxidation of ethylene to produce ethylene oxide practiced by U. S. Industrial Chemicals, Inc. in its plant at Baltimore, Maryland. The development of its process took place under my direction, mostly in the years 1936 and 1937. On completion of the development work, the necessary engineering study of commercial operation was made and the design of and equipment for a commercial plant was developed. When that had been completed, a commercial plant was built and equipped and it was started on commercial production in 1939. All of this work was done by me or by my assistants and associates, and with all of it I was intimately familiar, including all of the studies relating particularly to the size and cost of a plant which would be commercially profitable. Since commercial operation of the plant started in the spring of 1939, I have been intimately familiar with the operation of the plant and the results obtained there.

On the basis of the information obtained by me in the course of the work thus outlined, I state that a plant suitable for commercial operation in the direct oxidation of ethylene to produce ethylene oxide and of a size and having the equipment appropriate for practicing the process profitably would cost more than One-half Million Dollars and would, in my opinion, cost approximately Seven Hundred Fifty Thousand Dollars or more. The operation is of such a nature that it must be conducted upon a substantial scale to present opportunity for profitable operation. A plant of such smaller size as to reduce its cost substantially below the Three-quarter Million Dollars stated above would, in my opinion, be unsuitable for

profitable commercial production and could not be operated profitably. Also, any existing plant could not, in my opinion, be reconstructed or rearranged for practicing the process of direct oxidation of ethylene at materially less cost than building an entirely new plant; specifically a plant for practicing the chlorhydrin process referred to above would not be adapted at all for reconstruction for practicing the direct oxidation.

One reason why the cost of building and equipping such a plant is high is that the operation of oxidizing ethylene is hazardous in that there is an ever-present danger of explosion. Because of this, the equipment must include unusually elaborate safeguard against creation anywhere in the plant of conditions which might bring about an explosion. The number, intricacy and delicacy of these protective devices add greatly to the cost of installation and operation, and commercial operation without them could not be considered because of the hazard.

FLOYD J. METZGER

Subscribed and sworn to before me
this 1st day of October, 1941.

M. FRANCES BRYAN
Notary Public, New York County,
New York County Clerk's No. 297
New York County Register's No. 3-B-61
Commission Expires March 30, 1943.

(Seal)

Affidavit of Walter J. Lehman

SUPREME COURT OF THE UNITED STATES

U. S. Industrial Chemicals, Inc.,
Petitioner,

v.

Carbide and Carbon Chemicals Corporation,
Respondent.

AFFIDAVIT

State of Pennsylvania }
County of Philadelphia } ss.:

Walter J. Lehman, being first duly sworn, deposes and says as follows:

My name is Walter J. Lehman. I am a citizen of the United States. I reside at 5128 N. 15th St., Phila., and I have resided there for eighteen years past.

I am Production Manager of Publicker Commercial Alcohol Company. I have been connected with that company for over three years and have been its Production Manager for over three years.

The Publicker Commercial Alcohol Company is and for many years past has been engaged in the commercial production of alcohol and related products. The company has long been interested in the production of ethylene oxide

and the methods and apparatus suitable for producing it profitably in commercial quantities. The engineering staff of the company and independent engineers serving the company have made a careful study of such methods and apparatus over several years past.

I and other representatives of my company have been familiar with the litigation of the Lefort reissue patent on which the above-entitled suit is based and representatives of my company attended the trial of the suit.

In my position as Production Manager of Publicker Commercial Alcohol Company, I have been intimately familiar with commercial operations in the United States in the production of alcohol and related products, including ethylene oxide, and have known what companies were engaged in such operations, at what locations and by what methods. On the basis of the knowledge so acquired by me, I state it to be a fact that the two companies which are the litigants in this suit are the only companies who are engaged in the commercial production of ethylene oxide in the United States by a process of direct oxidation of ethylene. Ethylene oxide is produced commercially by another method and has been for a great many years past; that other method is sometimes referred to generally as indirect oxidation but more often as the chlorhydrin process.

Also on the basis of studies made by the staff of my company and independent engineers whose services have been retained by my company, I state it to be a fact that a plant for the production of ethylene oxide by direct oxidation of ethylene must be one of substantial size if it is to be commercially profitable. It is my opinion, based upon the elaborate studies referred to above that such a plant would

cost more than One-half Million Dollars and I think its cost would be $750,000.00 or more. A plant of a sufficiently smaller size to make its cost substantially less than the amount above named could not, in my opinion, be operated to produce a profit. Also, any existing plant could not, in my opinion, be reconstructed or rearranged for practicing the process of direct oxidation of ethylene at substantially less cost than building an entirely new plant; specifically a plant for practicing the chlorhydrin process referred to above would not be at all adapted for such reconstruction and only a small part of the apparatus usually employed in it would be useful in such a reconstructed plant.

One reason why the cost of building and equipping such a plant is high is that the operation of oxidizing ethylene is hazardous in that there is an ever-present danger of explosion. Because of this, the equipment must include unusually elaborate safeguards against creation anywhere in the plant of conditions which might bring about an explosion. The number, intricacy and delicacy of these protective devices add greatly to the cost of installation and operation and commercial operation without them could not be considered because of the hazard.

WALTER J. LEHMAN

Subscribed and sworn to before
me this 2 day of Oct., 1941.

JOSEPH W EGENDORF
Notary Public
My Commission Expires
January 6th, 1945

(Seal)

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FILED
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IN THE

Supreme Court of the United States

OCTOBER TERM, 1941

No. 680

U. S. INDUSTRIAL CHEMICALS, INC.,
Petitioner,

vs.

CARBIDE AND CARBON CHEMICALS CORPORATION,
Respondent.

REPLY BRIEF FOR PETITIONER

WILLIAM H. DAVIS,
Counsel for Petitioner.

THOMAS D. THACHER,
DEAN S. EDMONDS,
CHARLES W. RILEY,
W. PETERS BLANC,
Of Counsel.

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Respondent.

REPLY BRIEF FOR PETITIONER

We submit the following reply to the respondent's brief.

I.

The "same invention"

Respondent's brief does not controvert the fact basis for the petition for certiorari, namely, that in the reissue patent the voluntary addition of water is optional, whereas in the original patent the voluntary addition of water is mandatory, as was stated specifically by the lower Court as follows:

1. "the voluntary introduction of water was a mandatory provision of the original Lefort patent" (App. R. 176).

2. "the reissue patent does *not* contemplate the voluntary introduction of water" (App. R. 176).

3. "*there is a difference* here in that the original patent contemplated the voluntary introduction of water * * * as a step that would always be taken * * * while Claims #8 and #9 [of the reissue] contain no such requirement, and indeed seem to negative clearly any such step" (App. R. 177).

Petitioner's position is that, this being the fact, the interpretation of the reissue statute adopted by this Court requires, as a matter of law, that the reissue claims must be declared invalid.

Respondent's brief does not discuss this matter. It includes no reference to the facts stated above by quotation from the lower Court's opinion. It discusses only the false issue of the scientific aspect of the change, relying upon findings of the lower Court that, from a technological standpoint, the difference between the original and reissue patents is not essential, vital, material or substantial because the same result can be obtained whether water is voluntarily added or not. This is an evasion of the very point before the Court.

Petitioner's position is that where a patentee asserts a step of a process as *mandatory*, as was found to be the fact here, he thereby makes it an essential part of his invention and a limitation on his monopoly. Having conceived the process as one in which that step must necessarily be taken and so informed the public in his original patent, he cannot thereafter reissue the patent to omit the step asserted as mandatory in the original merely because afterthought or further investigation reveals that as a matter of scientific

fact a similar result may be achieved even though the step be omitted. Such a reissue is for a different invention as a matter of law regardless of the scientific or technical aspect of the change. That is the interpretation of the reissue statute adopted by this Court and stated in the decisions of this Court and of the Courts of Appeals cited in our main brief. The ruling of the Court below is in direct conflict with those decisions. Respondent offers nothing by way of distinguishing the instant case from the conflicting decisions in which such a reissue has been held invalid; it refers to many cases in its brief, but it does not present any case validating a reissue patent which makes permissive a step in a process described as mandatory in the original.

Also, respondent's brief erroneously states that the Courts below rested their rejection of the defense of different invention upon findings in which they concurred. The District Court accepted the contention of respondent, repeated in its brief before this Court (Res. Br., p. 9) and urged by respondent before the Court of Appeals, that the description of the original patent makes the introdacion of water permissive and optional (Supp. R. 8, 9, 12). The Court of Appeals rejected that contention, holding expressly that the description of the original patent makes the introduction of water mandatory. Thus, instead of concurring views of the lower Courts as is made to appear in respondent's brief, the lower Courts have recorded conflicting views on this issue of "same invention."

Respondent says (Br. p. 13) there are two cases involving this issue of "same invention" decided by this Court since the organization of the Courts of Appeals contrary to the statement on page 21 of petitioner's brief. Those two cases did require some consideration of this "same in-

vention" issue along with other issues of patentable novelty and scope. They add nothing of interest here to what appears in the cases we cited beyond specific applications of the principles which this Court had enunciated.

In *Abercrombie & Fitch Co.* v. *Baldwin*, 245 U. S. 198, the original patent under consideration described a certain stirrer as having its end bent, and the specification of the reissue included the statement that "it is obvious that the stirrer need not always be formed with a bent end." This Court, in rejecting the contention of new matter, said (p. 208):

> "One or the other might be better, according to the extent of the dispersion required, and *one naturally suggested the other.*" (Emphasis ours.)

That case lends no support to respondent. This appears from the quoted statement, for it is plain that to assert a step as mandatory does not "naturally suggest" that it may be omitted.

The other case, *Vandenburgh* v. *Truscon Co.*, 261 U. S. 6, held a reissue invalid on the ground that a patent cannot be extended by reissue to a field beyond its original intention in accord with all of the many other decisions of this Court from *Burr* v. *Duryee* in 1873 (1 Wall. 531), to *Olin* v. *Timken* in 1894 (155 U. S. 141).

II.

Intervening Rights

The conflict of decision between the Court of Appeals of the Fourth Circuit in this case and the Court of Appeals for the Second Circuit in the *Otis Elevator* case is of great consequence. It involves the availability of the defense

of intervening rights to one who engaged in experimental and development work prior to the reissue and by that experimental work completed the development of his process prior to the reissue, but who did not get the actual commercial use of the process under way until after the grant of the reissue. The Court below held that intervening rights do not arise where the intervenor's activity prior to the reissue was confined to experimental and development work. The Court of Appeals for the Second Circuit held that intervening rights can be predicated upon experimental and development work prior to the reissue leading by an unbroken succession of events to commercial use after the reissue (Pet. Br., pp. 25-26).

Respondent's brief does not discuss this question. Instead, it discusses whether the date of application for reissue, or the date of its grant, is controlling, a question which is of no moment here because, of the total sum of $151,000.00 spent by petitioner on its experimental and development work, $132,000.00 was spent prior to the application for the reissue and $19,000.00 more before the reissue was granted (Supp. R. 226).

III.

Further litigation improbable

Respondent does not question the statement of fact in the petition that a plant for the production of ethlyene oxide by the accused process of a size offering any prospect of profit would cost in excess of half a million dollars. A smaller plant, costing less, would be unprofitable and could be ignored by the patent owner for he would know that its

operation would be discontinued ultimately. It would not be necessary to sue such an infringer and doubtless the patent owner would not hazard his patent or incur the expense of a suit to suppress such harmless competition.

Respondent says there are potential infringers in other circuits and of that we entertain no doubt. Our statement is that those potential infringers will not become actual ones. Respondent does not take issue with that, and in that fact lies the reason why there will not be litigation of this patent in another circuit.

Respectfully submitted,

WILLIAM H. DAVIS,
Counsel for Petitioner.

THOMAS D. THACHER,
DEAN S. EDMONDS,
CHARLES W. RILEY,
W. PETERS BLANC,
Of Counsel.

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No. 680

IN THE

Supreme Court of the United States

OCTOBER TERM, 1941

U. S. INDUSTRIAL CHEMICALS, INC.,
Petitioner,

vs.

CARBIDE AND CARBON CHEMICALS CORPORATION,
Respondent.

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE FOURTH CIRCUIT

BRIEF FOR PETITIONER

WILLIAM H. DAVIS,
Counsel for Petitioner.

THOMAS D. THACHER,
DEAN S. EDMONDS,
W. PETERS BLANC,
Of Counsel.

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STATUTE CITED

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IN THE

Supreme Court of the United States

OCTOBER TERM, 1941

No. 680

U. S. INDUSTRIAL CHEMICALS, INC.,
Petitioner,

vs.

CARBIDE AND CARBON CHEMICALS CORPORATION,
Respondent.

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE FOURTH CIRCUIT

BRIEF FOR PETITIONER.

Opinions Below

The opinion of the Circuit Court of Appeals (R. Vol. II, pp. 173-187) is reported in 121 F. (2d) 665. The opinion of the District Court (R. Vol. I, pp. 3-22) is reported in 34 F. Supp. 813.

Jurisdiction

The decree of the Circuit Court of Appeals which petitioner seeks to have reviewed was entered June 29, 1941 (R. Vol. II, p. 187). The petition for writ of certiorari was

filed on October 4, 1941, and was granted on November 10, 1941. The jurisdiction of this Court rests upon Section 240 (a) of the Judicial Code as amended by the Act of February 13, 1925, c. 229 (28 U. S. Code, Sec. 347).

Questions Presented

The questions presented are:

(1) Can a patent for a process which includes a step asserted to be mandatory and described and claimed in the original patent as an essential feature of the patented invention be reissued to include a process which achieves the same result while dispensing with the step referred to?

(2) Does one who in good faith and at great expense completely develops a process which does not infringe an original patent, but which does infringe the broadened claims of a reissue thereof granted after the development work is complete but before the new process is put into commercial use, acquire intervening rights barring injunctive relief against commercial use of the process?

Statute Involved

The reissue statute, R. S. Sec. 4916, is printed in full in the appendix hereto, page 55.

STATEMENT OF FACTS

This is a suit in equity brought by respondent against petitioner in the United States District Court for the District of Maryland for alleged infringement of claims 8 and 9 of reissue patent 20,370, granted May 18, 1937, on an application for reissue filed September 25, 1936. The

reissue patent is founded upon original patent 1,998,878, for a "Process for the Production of Ethylene Oxide," granted April 23, 1935, on an application filed March 22, 1932. The patents were granted in the name of Theodore Emile Lefort, of Paris, France. They are based upon earlier French patents, the first of which was applied for on March 27, 1931 (R. Vol. I, p. 367).

The District Court held claims 8 and 9 of the reissue patent valid and infringed and entered the usual interlocutory decree (R. Vol. I, p. 3; 34 F. Supp. 813). On appeal to the Circuit Court of Appeals for the Fourth Circuit, the decree was affirmed (R. Vol. II, p. 173; 121 F. (2d) 665).

The case is here on writ of certiorari issued because of conflict between the decision of the Circuit Court of Appeals for the Fourth Circuit in this case and decisions of this Court and of the Courts of Appeals for other circuits.

The Catalytic Oxidation Process

The several Lefort patents deal with oxidation by catalytic reaction. The chemical principles and reactions which must be understood for the purpose of dealing with this suit may be explained briefly and understood readily, and they are not the subject of substantial dispute.

There are many substances available for use whose utility and value are increased by oxidizing them, that is, causing one or more atoms of oxygen to unite with each molecule of the substance to be oxidized. With some substances this reaction of oxidation is a simple one which can be made to occur by merely bringing the oxygen and the substance to be oxidized into contact. With others the oxidation does not occur readily and special expedients must be employed to effect it.

One such special expedient is the utilization of a catalyst, a substance which merely by its presence causes a chemical union or reaction when the two substances are brought into contact under appropriate conditions in the presence of the catalyst, a union or reaction which would not occur under those conditions in the absence of the catalyst (R. Vol. II, pp. 4-5).

The patent in suit relates to a process of oxidizing ethylene gas by catalytic action to form ethylene oxide. One major use of ethylene oxide is to form an anti-freeze solution for cooling automobile engines, for which use it is better than alcohol because it does not evaporate (R. Vol. II, p. 4). The chemical formula of ethylene gas is C_2H_4 which indicates a molecule consisting of two atoms of carbon and four atoms of hydrogen. The chemical formula of ethylene oxide is C_2H_4O, representing the chemical union of one atom of oxygen with an ethylene molecule (R. Vol. II, pp. 3-4).

Prior to the patents involved in this suit, ethylene oxide in what might be called the hydrated form known as ethylene glycol was available commercially and was in use to some extent. It was made by an *indirect* procedure in which two or more chemical unions or reactions occur successively to derive liquid ethylene glycol from ethylene gas (R. Vol. II, pp. 5-8). Later, when the demand for ethylene oxide and ethylene glycol expanded as it did (R. Vol. I, p. 221), it became desirable to produce them by a less expensive procedure, and that led to the development of the process of *direct* oxidation with which we are here concerned.

The direct oxidation process has one drawback. In addition to the main reaction producing ethylene oxide, a side reaction whereby a portion of the ethylene is con-

verted to useless by-products, carbon dioxide and water, invariably occurs. In the degree to which the ethylene subjected to the process is used up in the formation of these waste products, the efficiency of the process is impaired. This undesirable side reaction is apparently inherent in the process and in practice has never been completely eliminated (R. Vol. II, pp. 11; 33; 41; 97; 104). By proper control of the oxidation, however, this undesirable side reaction can be held within economic limits.

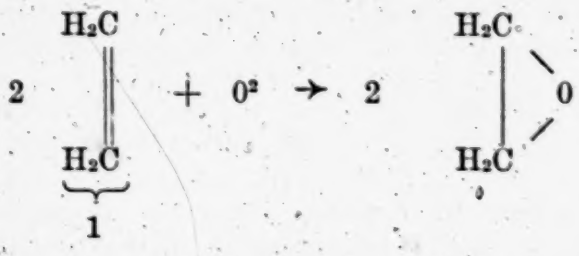
The Original Lefort Patent

A copy of this patent is, for convenience, included in the appendix hereto at page 57.*

The specification opens with a concise statement of the invention (1/1/1-6):

> "This invention has for object a process for the production of ethylene oxide which mainly consists in subjecting ethylene *to the simultaneous action of the oxygen of air and of water,* in presence of a catalyzer and, if need be, of hydrogen."

The chemical formula expressing the oxidation of ethylene to ethylene oxide (1/1/11-15) is given as:



* References to the patents will be cited as: (1/1/1-6) i. e. page 1, column 1, lines 1 to 6. Throughout the brief, emphasis, unless otherwise noted, is ours.

The specification mentions first the optional use of hydrogen (1/1/7-9) and then refers at some length to the catalyzer, enumerating the metals and combinations of metals which may be employed (1/1/22—1/2/5). Since no issue relating to the role of either of these factors in the process is before the Court, these passages need not be dwelt upon.

The specification then proceeds (1/2/6-13) with some facts about the sources from which the three elements named as reactants in the introductory statement of the invention can be obtained and the form in which they may be used. It states:

> "The ethylene can be obtained from any source of supply: gas from coke ovens, hydrogenation of acetylene, dehydration of ethyl alcohol, and the like.
>
> Water can be admitted in the reaction vessel, either in the liquid state, or as steam.
>
> The oxygen can be oxygen of the air, this latter gas being introduced in the reaction."

As to the significance of the water introduced into the process the patentee says (1/2/14-18):

> "The efficiency of the reaction is increased by diminishing the CO_2 which is formed, by introduction, in this reaction, of a suitable quantity of water. A suitable volume of CO_2 can also be previously introduced in the reacting gases."

The CO_2 which the patentee expresses a purpose to diminish is the CO_2 formed in the course of the undesirable side reaction producing carbon dioxide and water referred to *supra* pages 4 and 5.

The specification refers again (1/2/30-43) to this undesired side-reaction, and discusses at greater length the

part which the introduction of water into the reaction chamber plays in that connection. It says:

> "Moreover, the applicant has found that the reaction giving CO_2 is, contrarily to previous belief, a reaction of oxidation independent from that giving ethylene oxide and from that giving aldehydes. From experiments effected by the applicant, it results that, if water is introduced in suitable quantity, the reaction is not only facilitated, as above stated, but, in addition, the reaction giving CO_2, probably by direct oxidation of ethylene according to the equation:
>
> $$C_2H_4 + 3O_2 = 2H_2O + 2CO_2$$
>
> is *checked*, owing, as is probable, to the partial pressure of water."*

The specification then goes on to say that the experiments referred to indicate that the side reaction producing the undesired CO_2 and water may be "completely checked" and the efficiency of the reaction producing ethylene oxide considerably increased if CO_2 is initially introduced into the reaction chamber in proper quantity along with the ethylene, air and water (1/2/44-51).

Then the specification, by way of example, sets forth three "modi operandi" for utilizing the patented process. In all three of the "modi operandi" described, each of the reactants named in the introductory statement of the invention, ethylene, the oxygen of air, and water, is specifically included, and in each of the three it is directed that

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* This equation $C_2H_4 + 3O_2 = 2H_2O + 2CO_2$ indicates that the side reaction forms water (H_2O) as well as carbon dioxide (CO_2) and that whenever CO_2 is formed by the side reaction, a proportional amount of water is formed at the same time. Checking the side reaction to diminish the formation of carbon dioxide will likewise diminish the formation of water.

water shall be introduced into the reaction vessel along with the ethylene and air, either in the liquid state or as water vapor, *i. e.*, steam.

In *Modus operandi I* (2/1/5-25) a mixture of air and ethylene is compressed and then led, "together with hydrogen or not," into a reaction tube containing one of the catalyzers listed in the patent, and it is said that the reaction tube communicates with "a circulating pump *allowing to introduce water* under pressure." It is stated that (2/1/20-21):

> "The reaction will take place in this tube between ethylene, the oxygen of air, *and water.*"

In *Modus operandi II* (2/1/28-39) silver, one of the catalyzers enumerated, in powder form or in the form of a wire gauze, is introduced into the reaction tube, and after the tube has been suitably heated, a mixture of ethylene, air, *water vapor,* and hydrogen is caused to pass through it. The ethylene oxide so produced is separated from the gases issuing from the tube.

In *Modus operandi III* (2/1/41-49) a silver colloid is introduced in a high pressure tube which has been *filled with water.* Pure ethylene under pressure is then dissolved in the water. The tube is then heated and air and hydrogen are slowly introduced until all of the ethylene is converted into ethylene oxide.

The patentee then points out that from the ethylene oxide produced according to the processes indicated above, it is possible to obtain certain derivatives of ethylene oxide including ethylene-glycol (2/1/50-59).

The specification concludes with another statement dealing with the importance to the attainment of the desired result of introducing into the reaction vessel a suitable

amount of water either in the liquid state or as steam. The statement is (2/2/1-5):

> "The experiments effected by the applicant have shown that, in presence of the catalyzers indicated, water, in the form of steam or not, considerably promotes the reaction ensuring the production of ethylene oxide."

Thus, as disclosed in the specification of the original patent, the invention is a process for the production of ethylene oxide which consists broadly in subjecting ethylene to the simultaneous action of oxygen, which can be the oxygen of air, *and water,* which has been *added* to the reaction vessel either in the liquid state or as steam, or mixed with the ethylene and oxygen in advance, in the presence of certain named catalysts placed in a reaction tube or chamber in which the temperature is maintained within a specified range.

Certain permissible variations of the process are disclosed in the specification. These alternatives relate to (1) the admission of hydrogen to the reaction chamber along with the ethylene, air and water (1/1/7-9); (2) the wide range of pressures at which the operation may be conducted (1/1/16-20; 1/2/19-21; 1/2/51-54); (3) the wide range of temperatures within the reaction chamber which may be employed (1/1/20-21); (4) the wide variety of catalysts which may be used (1/1/22-1/2/5; 1/2/22-30); and (5) the introduction of CO_2 into the reacting gases (1/2/17-18; 1/2/44-51). No variation with respect to the introduction of water into the reaction chamber is suggested.

The original patent contains seven claims. All of them correspond to the subject matter of invention set forth in the specification. All seven specify a process for the pro-

duction of ethylene oxide consisting in subjecting ethylene to the simultaneous action of *oxygen and water* in the presence of a catalyst. In claims 4 to 7, the water is stated to be in the form of steam, and in claims 6 and 7 it is stated that hydrogen is also admitted.

From the foregoing description, it is evident, and the Court below so held, that the process contemplated in the original patent is one in which the introduction of water into the reaction chamber along with the ethylene and oxygen is mandatory, the introduction of water being described, not as an optional procedure, but as a step in the process always to be taken (R. Vol. II, p. 176).

The Circumstances Leading to the Reissue Application

The original Lefort patent was issued April 23, 1935. It was assigned by Lefort, like the antecedent French patents, to a French company named Société Francaise de Catalyse Généralisée, referred to hereinafter as the French Company. Respondent, Carbide & Carbon Chemicals Corporation, obtained title to the original patent by purchase from the French Company, arrangements for the purchase being concluded in March or April, 1936 (R. Vol. I, p. 269; Vol. II, p. 61).

Simultaneously with this purchase, respondent became dissatisfied with what had been secured as the subject matter of the original patent. Respondent's dissatisfaction arose as the result of a study of the patent by Emory P. Boynton, one of respondent's patent attorneys, who had been asked to say "whether or not the patent would cover the process disclosed in it" (R. Vol. I, p. 268).

In February or March of 1936, just prior to Mr. Boynton's study of the patent, an investigation of the oxidation

of ethylene in accordance with the disclosure of the original Lefort patent was undertaken by respondent's technical staff (R. Vol. I, pp. 260-61, 263). The first series of tests conducted were failures in the sense that no ethylene oxide was produced (R. Vol. I, p. 265). Experimental work was continued, however, and as a result it was concluded that ethylene oxide could be produced on an industrial scale by a process *which does not involve the addition of water in any form* to the mixture of ethylene and air passed through the reaction chamber containing the catalyst, but instead consists in passing only ethylene and air over the catalyst (R. Vol. II, p. 60; Vol. I, pp. 262-3). Mr. Boynton's study of the patent began after the technical staff had obtained "positive results" and was made with some knowledge of this experimental work (R. Vol. I, pp. 268-9 and 271).

Mr. Boynton's study of the patent brought him to the conclusion that Lefort should have obtained "far broader claims" in his patent. He said "it was apparent that because of the way that the French solicitor had prepared the original U. S. Application from these French patents that it would be virtually impossible to claim the invention broadly so as to cover it *whether or not water was even present, added or introduced or formed.*" He concluded that such "far broader claims" might be obtained by a reissue of the original patent (R. Vol. I, pp. 275-276).

Respondent communicated these conclusions to Lefort, and Mr. Boynton prepared and transmitted to Lefort in Paris, France, an application for reissue of the original patent, including a form of oath to be made by Lefort in support of the application.* Lefort executed the papers

* The assignment agreement transferring patent 1,998,878 to respondent contained a covenant binding the French company to sign all papers requisite for obtaining a reissue of the patent (R. Vol. I, p. 445).

sent to him, and they were filed in the Patent Office on behalf of respondent on September 25, 1936, as application Serial No. 102,613 (R. Vol. I, pp. 268-276 and 309 *et seq.*).

The Reissue Application and Oath

The oath made by Lefort in support of the reissue application as originally filed sets forth that respondent, through its technical representatives and patent counsel, had observed and ascertained certain defects in the original patent. These defects, according to the oath, include the following (R. Vol. I, p. 322):

> "(a) The specification and claims do not emphasize sufficiently clearly that the process of oxidizing ethylene to ethylene oxide is operable *whether or not water is present*, and that the presence of water in the reaction is but one preferred embodiment of the invention * * *."

The defects, it was said, arose and occurred (R. Vol. I, p. 323):

> "through failure of the applicant and his attorney to appreciate fully the relation of the claims to the preferred scope of the invention, and failure of applicant to instruct adequately his attorney in the fullest benefits and application of his invention, namely, in the production of ethylene oxide by oxidation of ethylene in the presence of catalysts *with or without the inclusion of water in the reaction.*"

The Proceedings in the Patent Office

The Patent Office Examiner to whom the reissue application was referred allowed the seven claims of the original patent which were retained in the reissue application in substantially their original form (R. Vol. I, p. 326), but all

of the new and broader claims were rejected by the Examiner as being "without patentable merit" in view of certain references cited. In addition to the rejection on that ground, the Examiner said (R. Vol. I, p. 325):

> "It is noted that in presenting the original case and also in distinguishing over this reference in the original applicant finally restricted the claims to specified catalyst and indicated that such catalysts *and the presence of steam* enabled increased yields. In other words, the case was presented as an improvement over prior known processes of oxidation of ethylene, so as to increase the yield of ethylene oxide. It appears to be too late to now urge that applicant is the pioneer inventor of processes of oxidizing ethylene."

Following this rejection, on March 13, 1937, a private conference was held with the Examiner (R. Vol. I, p. 337), and on April 10, 1937, thereafter, respondent filed a new specification differing considerably from the one previously filed (R. Vol. I, p. 333) and another supporting oath by Lefort (R. Vol. I, p. 338). In contrast with the statement in the first reissue oath that the defect of the original patent lay in the failure to emphasize clearly that the process was operable "*whether or not water is present*" and "*with or without the inclusion of water in the reaction*", the second oath asserts that the defect of the original patent consists in (R. Vol. I, p. 340):

> "the failure more clearly to point out that *a substantial quantity of water is inherently present in the reaction tube* due to the substantial independent oxidation of ethylene to carbon dioxide and water, the failure to make clearer that the addition of water or carbon dioxide or both *to augment the water and carbon dioxide inherently and independently formed,* as well as the addition of hydrogen, are merely supplemental features still within the scope of the real invention * * *."

This second oath goes on to explain these failures as follows (R. Vol. I, p. 342):

> "Deponent through inadvertence failed to stress to his attorney the point that a substantial quantity of water was *inherently present* by reason of independent complete oxidation of some of the ethylene giving water and carbon dioxide, and that *any augmentation* of this water by the direct addition of water to the reaction zone might be practiced or omitted as desired."

The thought behind this statement in the supplemental oath—that the object of the direction to introduce water into the reaction chamber was to *augment* the quantity of water existing there by reason of the side reaction—is quite the reverse of the thought of the original patent, which specifically states that one of the functions of the water introduced into the reaction chamber is, not to *augment* the CO_2 and water formed by the side reaction, but to *diminish* them by checking the side reaction or eliminating it completely (1/2/14-18; 1/2/30-51; *supra*, pp. 6 and 7).

By the new specification filed as above stated along with this second oath, the claims which had been rejected by the Examiner were withdrawn and two new claims were presented, numbered 19 and 20 (R. Vol. I, p. 335). Those two claims, with one minor change, are claims 8 and 9 of the reissue patent here in suit (R. Vol. I, pp. 363-365).

The Reissue Specification

A copy of the reissue patent is also included in the appendix hereto at page 59.

The rewritten description of the process which appears in the reissued patent begins with a summary statement about the invention sought to be secured (1/1/1-8):

"This invention provides a specific and novel process for making ethylene oxide. It essentially consists in causing ethylene *to combine directly with molecular oxygen* at temperatures of about 150° to about 400° C. in the presence of a surface catalyst which favors the oxidation of ethylene to ethylene oxide under these conditions."

The specification then states that the process can be carried out at atmospheric pressure or at pressures above or below atmospheric pressure; and that the chemical reaction produced by the process is one in which the direct addition of a single oxygen atom to the ethylene molecule occurs without the formation of significant amounts of other oxygenated compounds such as aldehydes (1/1/8-17).

This is followed by the chemical expression of the two reactions which occur in the process, the main reaction which produces ethylene oxide and the side reaction which produces carbon dioxide and water (1/1/17-25). These equations of the reissue patent differ in form from the equations appearing in the original patent at 1/1/11-15 and 1/2/41 respectively, but they have the same chemical significance.

The specification next states that ethylene from any desired source may be used; and that the oxygen employed can be oxygen of the air, and can be conveniently mixed with the ethylene prior to the reaction (1/1/26-32).

The specification then makes the sole reference to the introduction of water to the reaction chamber contained in the reissue patent (1/1/33-42):

"The oxidation of ethylene takes place with a giving off of heat, and it is, of course, desirable to maintain the temperature of the zone of reaction within the range specified. This can be facilitated

by suitable dilution of the reaction gases, such as that accomplished by the use of air as the source of oxygen, *and some water or carbon dioxide in addition to that formed can be admitted to the mixture in the reaction zone if desired.* Hydrogen may be similarly added."

The specification then proceeds to set forth a mode of operating the process. The procedure described is in substitution for the three *modi operandi* of the original patent and approximates most closely *Modus operandi I* though it differs from all three in that no water is added to the reaction chamber (1/1/43—1/2/3):

> "The process can be conveniently conducted by passing a mixture containing air and ethylene through a tube, for example, of silica or of a material capable of withstanding high pressures, within which is placed such a surface catalyst as one composed of silver in finely divided form, and which may be disposed within the tube on a supporting material, or in other known ways. The temperature of the reaction zone is maintained between about 150° and about 400° C., for example, at about 200° C., and the issuing products from the tube contain ethylene oxide, carbon dioxide and water without objectionable aldehydes. The ethylene oxide can be recovered in any suitable way, preferably in liquid form by condensation or solution."

After a paragraph (1/2/4-11) referring to the catalyst, the new specification concludes as follows (1/2/12-19):

> "In any case, the ethylene and oxygen are thus reacted simultaneously at the temperatures set forth in the presence of a surface catalyst and of water, and the process is conducted to produce ethylene oxide as a direct product in substantial and economic amount. The ethylene oxide can be recovered by known methods, and it may be further reacted to

form ethylene glycol or derivatives of ethylene glycol."

Claims 8 and 9 of the Reissue

The reissue patent contains nine claims. Claims 1 to 7, except for slight changes in form, are identical with the seven claims of the original patent. They are not charged to be infringed by petitioner's process. Claims 8 and 9 are the new claims obtained by the reissue and infringement is alleged as to them only.

These claims 8 and 9 are broader than the claims of the original patent. They include no reference to the introduction of water into the reaction chamber, and no reference to "subjecting ethylene to the simultaneous action of the oxygen of air and of water" as stated in the original description and in all of the other claims. They conform to the changed description of the reissue that water is to be introduced only "if desired."

The first step of the process defined in claims 8 and 9 of the reissue is "forming a mixture containing ethylene and molecular oxygen." This mixture may be a mixture of ethylene and air, as appears in the reissue specification (1/1/29-31), or of ethylene and dry oxygen (R. Vol. II, p. 93). The inclusion of water as one of the reacting ingredients entering the reaction chamber is not required.

It is also stated in claims 8 and 9 that the catalyst to be used is one which favors the reaction "in the presence of water." This limitation, however, does not require that water be introduced into the reaction chamber along with the ethylene and air as one of the ingredients which are to react and combine in the presence of the catalyst. It is fulfilled by the presence of that small quantity of water

produced by the side reaction forming carbon dioxide and water.

Thus claims 8 and 9 of the reissue patent are broad enough to cover, and do cover, a process from which the step of introducing water into the reaction chamber has been omitted. This is the interpretation placed upon these claims by respondent (R. Vol. I, p. 281), and it is the interpretation which they must bear in order to sustain the charge of infringement.

The Court below found as fact that the reissue patent does not contemplate the voluntary introduction of water into the reaction chamber as a necessary step in the procedure and that claims 8 and 9 "seem to negative clearly any such step" (R. Vol. II, pp. 176, 177).

Petitioner's Process

Petitioner is engaged in the commercial production of ethylene glycol in its manufacturing plant at Baltimore, Maryland. As one of the steps in such manufacture, ethylene oxide is produced by passing a gaseous mixture of ethylene and the constituents of atmospheric air (including a substantially normal water vapor content, R. Vol. I, p. 279) through a chamber containing a catalyst consisting of silver disposed upon a carrier of aluminum oxide bonded by a fusion process, the mixture being passed continuously through the chamber in intimate contact with the catalyst during an extended period of time. Throughout the operation the temperature within the chamber is maintained between about 150° and about 400° C. As a result, ethylene oxide is produced in substantial amount, and the resulting gaseous mixture containing the ethylene oxide is passed out of the chamber continuously during the operation.

Thereafter, the ethylene oxide is dissolved out of the mixture into an acidified aqueous medium, and is reacted in the solution to form ethylene glycol (R. Vol. I, pp. 279-280).

Petitioner's process was developed as a result of research and development work which began in January, 1934, and was carried on continuously through the next three years. Petitioner's researchers had knowledge of the Lefort French patents and the original U. S. patent and the limitations contained therein during this work (R. Vol. I, pp. 196; 223). Through the first two years of this period, the research covered catalytic operations both with and without water. Toward the end of 1935, the idea of introducing water into the reaction chamber along with the ethylene and oxygen was definitely discarded (R. Vol. I, pp. 222-4).

By the end of 1936, a commercial process had been developed and in the spring of 1937 an application for patent covering that process was filed and a patent has since issued thereon (R. Vol. I, pp. 217; 224-5).

In April, 1937, plans for a large pilot-plant were started and at the same time estimates for a commercial plant were undertaken. The pilot-plant was built and went into operation in the middle of 1937. After extended operation of this pilot-plant, construction of petitioner's commercial plant near Baltimore, Maryland, was undertaken in the middle of 1938 and that plant was completed and put into operation on May 9, 1939, and has been in continuous successful operation ever since (R. Vol. I, pp. 217; 226).

Petitioner's expenditures upon the research and development work from its inception up to September 25, 1936, when the application for reissue of the patent in suit was filed, totaled about $132,000, and its further expendi-

tures on this research up to May 18, 1937, when the reissue patent was granted, totaled $19,000, an aggregate of $151,000 (R. Vol. I, p. 226).

The process so evolved by petitioner is within the description of the reissued patent and is within the broad claims 8 and 9 in suit as respondent maintains they should be interpreted. It is *not* within the description of the original patent, nor the claims of that patent, nor claims 1 to 7 of the reissue, and respondent has never asserted infringement of any of those claims."

The Proceedings in the Courts Below

In the Courts below, petitioner challenged the validity of claims 8 and 9 of the reissue upon the ground which is here for review, namely, that those two claims are not "for the same invention" as the original patent within the meaning of the Reissue Statute, R. S. 4916.

Petitioner also maintained that respondent is estopped from asserting claims 8 and 9 of the reissue against petitioner, even if those claims are valid, because of intervening rights acquired by petitioner with respect to the accused process prior to the date of the reissue.

The District Court rejected these defenses. In deciding the question of same invention, Judge COLEMAN concluded that "with respect to water, the specifications of the original patent are not *essentially* different from those in the reissued patent" (R. Vol. I, p. 9). Relying upon expert testimony as to the results obtained by the processes disclosed in the two patents, which he said "in the last analysis, should control," Judge COLEMAN found that "whether the addition of water be considered as manda-

tory or as optional" in the original patent, one skilled in the art, following the teachings of that patent, will obtain "the same result" that will be obtained if he follows the teachings of the reissued patent, and that this fact "conclusively demonstrates that there is no variance between the subject matter of the original and the reissued patent" (R. Vol. I, p. 10).

Judge COLEMAN made formal findings (R. Vol. I, p. 24) as follows:

> "7. There is no variance between the invention described in the specifications and claims of the original patent and in the specifications and claims 8 and 9 of the reissued patent in suit.
>
> 8. With respect to water, the specifications of the original patent are not essentially different from those in the reissued patent. Professor Arthur B. Lamb, testifying on behalf of the plaintiff, has satisfied the Court, through his very clear exposition of the character and results of his laboratory tests, that one skilled in the art, following the teachings of the original patent, will be successful in producing what that patent calls for, and in obtaining such result whether the addition of water be considered as mandatory or as optional, and that he will obtain the same result if he follows the teachings of the reissued patent in suit. In other words, what Professor Lamb accomplished by following the original patent proves not only the adequacy of its disclosure as to how to carry out the process successfully, but, in addition, conclusively demonstrates that there is no variance between the subject matter of the original and the reissued patent. This testimony is confirmed by the testimony of Professor Frazer, the inter-partes neutral witness, and also by that of Professor Stevenson and Dr. Curme, witnesses for the plaintiff."

The Court of Appeals affirmed the decree of the District Court (R. Vol. II, p. 173; 121 F. (2d) 665). In so doing, however, the Court found on a comparison of the specifications and claims of the two patents that the original patent describes, as the invention intended to be secured by it, a process in which the voluntary introduction of water into the reaction chamber is a mandatory step always to be taken, whereas the invention covered by claims 8 and 9 of the reissued patent includes a process in which the voluntary introduction of water into the reaction chamber is omitted.

The Court of Appeals made a "verbal analysis" of the specification of the original patent and stated its view as to the content of that patent as follows (R. Vol. II, p. 176):

> "We are convinced that this original patent contemplated the voluntary introduction of water into the reaction-chamber, not as an optional procedure, but as a step that would always be taken. The verbal analysis shows that, in the original patent, literally there is 'Water, water, everywhere'. Nor is it water developed as a by product, but it is water voluntarily introduced into the tube to bring about the desired reaction. * * * Some study of chemical history and literature, as these existed at the time of Lefort's labors, convinces us even more strongly of the truth of the conclusion that the voluntary introduction of water was a mandatory provision of the original Lefort patent."

The Court of Appeals then made a similar analysis of the specification of the reissue patent and stated its conclusion as to that as follows (R. Vol. II, p. 176):

> "It seems quite clear, on the other hand, that the reissue patent does *not* contemplate the voluntary introduction of water into the reaction-chamber as a

necessary step in the procedure." (Emphasis by the Court.)

The Court of Appeals then stated its further conclusion, derived from its findings as set forth in the two foregoing quotations, as follows (R. Vol. II, p. 177):

> "*there is a difference* here in that the original patent contemplated the voluntary introduction of water into the reaction-chamber (distinguished from the mere formation of water during the course of the reactions) as a step that would always be taken in the procedure therein set out, while Claims #8 and #9 contain no such requirement, and indeed seem to negative clearly any such step." (Emphasis and parenthesis by the Court.)

Having thus come to the conclusion that "there is a difference" between the original and the reissued patents on a comparison of their specifications and claims, the Court of Appeals then turned to the same line of testimony relied on by the District Court, the comparison of the *results* obtained by following the teachings of the two patents.

Referring to its finding of difference between the two patents, the Court said (R. Vol. II, p. 177):

> "Is this difference vital, essential, substantial, material? Judge Coleman answered this question categorically in the negative, in his Findings of Fact #7 and #8. Under Civil Rules of Federal Procedure, Rule 52(a), we can set aside these findings if, but only if, in our opinion the findings are 'clearly erroneous.'"

The Court discussed this issue at length and, like the District Court, rejected the defense of "same invention" on the strength of expert testimony to the effect that the dif-

ference which it had found to exist between the patents was not "vital, essential, substantial, material" from a technological point of view since the same ultimate result, namely, the production of ethylene oxide, is attained by both the process described in the original patent and the different process described and claimed in the reissue patent (R. Vol. II, pp. 180-181).

The defense of intervening rights was overruled by both of the courts below on the ground that petitioner's activity prior to the reissue was confined to experimental and development work and that the sum spent in this work was relatively small in comparison to the sums later expended in the erection and operation of petitioner's commercial plant (R. Vol. II, pp. 185-186).

Specification of Errors to Be Urged

The court below erred:

1. In failing to hold that claims 8 and 9 of the reissue patent in suit are invalid because they are not for the "same invention" as the original patent;
2. In failing to hold that injunctive relief against petitioner's use of its process is barred by petitioner's intervening rights.

Summary of Argument

The reissue statute has repeatedly been interpreted by this Court as rendering invalid reissue claims for mechanism or processes neither claimed nor described in the original patent as the invention intended or sought to be covered thereby. Claims 8 and 9 of the reissue in suit do cover

a process additional to and different from that described in the original patent as the process intended or sought to be covered thereby, and are therefore invalid.

Within the generality of the foregoing and as a specific instance thereof, when an original patent describes the machine or process sought to be secured thereby as one in which a certain element or step is mandatory, and a reissue of the patent describes that element or step as optional and contains broader claims covering the machine or process with that element or step omitted, such a reissue is invalid as to those broader claims as a matter of law. The original patent involved in this suit describes a process in which the introduction of water along with certain other ingredients into a chamber to participate in a reaction therein is a mandatory step and the reissue of that patent describes the process as one in which the introduction of water is an optional or permissive step and contains broader claims covering the process with the step of introducing water to the reaction chamber omitted. These broader claims, we submit, are therefore invalid.

Under the doctrine of intervening rights, we contend that one who in good faith has expended time, effort and money in the development of a process which does not infringe an original patent but does infringe the broadened claims of a reissue thereof granted after the development work is complete but before the process has been put into commercial use, is entitled to use the process he has developed free from the enlarged monopoly of the reissued patent.

ARGUMENT

1. Claims 8 and 9 of of the reissue patent in suit are invalid because they are not for the same invention as the original patent.

The Legal Principles Involved

The reissue statute, by its terms, limits the authority of the Commissioner of Patents to the reissuing of a patent "*for the same invention*" as that patented by the original patent. The statute emphasizes this requirement by providing that "no new matter shall be introduced into the specification" of the reissue. The authority granted by the statute being thus limited, a reissue patent is invalid where it appears that the reissue is not "*for the same invention.*" *Seymour* v. *Osborne,* 11 Wall. 516, 544-6; *Powder Co.* v. *Powder Works,* 98 U. S. 126; *Mahn* v. *Harwood,* 112 U. S. 354, 359.

The requirement that a reissue patent must be "for the same invention" has been in all the reissue statutes,* and the phrase, as it has appeared in the various statutes, has been before this Court for interpretation in numerous cases.

It has been determined that the requirement that a reissue patent must be "for the same invention" does not mean that the subject matter *claimed* in the reissue must be identical with that *claimed* in the original patent. Thus, a reissue patent containing a broader claim than the original may properly be granted. *Topliff* v. *Topliff,* 145 U. S. 156.

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* See discussion in *Parker & Whipple Co.* v. *Yale Clock Co.,* 123 U. S. 87, 96-7.

Also, the reissue may properly contain a narrower claim than the original. *Miller* v. *Brass Co.*, 104 U. S. 350, 353.

But it is settled that, in any event, by reason of the statutory restriction under consideration, a reissue patent must be confined to what appears as the invention which the patentee *attempted to cover* by the original patent, the "invention intended to have been secured" by the original patent, the "invention which the original patent was intended to cover." *Powder Co.* v. *Powder Works*, 98 U. S. 126, 138; *Parker & Whipple Co.* v. *Yale Clock Co.*, 123 U. S. 87, 99; *Flower* v. *Detroit*, 127 U. S. 563, 571; *Corbin Cabinet Lock Co.* v. *Eagle Lock Co.*, 150 U. S. 38, 43. It has been determined that such an intention or attempt does not appear when the additional matter embraced by the claims of the reissue is *not disclosed* in the original patent, *Clements* v. *Odorless Apparatus Co.*, 109 U. S. 641, 647; *Coon* v. *Wilson*, 113 U. S. 268, 277; *Gardner* v. *Herz*, 118 U. S. 180, 192-3; *Ives* v. *Sargent*, 119 U. S. 652, 662-3; *Hartshorn* v. *Saginaw Barrel Company*, 119 U. S. 664, 675; *Parker & Whipple Co.* v. *Yale Clock Co.*, 123 U. S. 87, 103-4; *Flower* v. *Detroit*, 127 U. S. 563, 569-72; *Electric Gas Co.* v. *Boston Electric Co.*, 139 U. S. 481, 501; *Freeman* v. *Asmus*, 145 U. S. 226, 239; *Huber* v. *Nelson Mfg. Co.*, 148 U. S. 270, 291-2; *Olin* v. *Timken*, 155 U. S. 141, 147, and that it will not avail the patentee in such case that the new matter covered by the reissue was actually within his knowledge at the date of application for his original patent. *Powder Co.* v. *Powder Works*, 98 U. S. 126, 138; *Manufacturing Co.* v. *Ladd*, 102 U. S. 408, 413; *Huber* v. *Nelson Mfg. Co.*, 148 U. S. 270. Similarly, decisions of this Court make it clear that the mere fact that an invention might have been claimed in the original patent, because it was suggested or indicated in the specification, is not enough

to warrant its claim in the reissue. They hold it *must also appear from the face of the patents* that what is covered by the reissue patent was *intended* to have been covered and secured by the original. *Parker & Whipple Co.* v. *Yale Clock Co.*, 123 U. S. 87, 99; *Flower* v. *Detroit*, 127 U. S. 563, 571.

The whole subject of the interpretation of the phrase "for the same invention" was reviewed and settled by this Court in *Parker & Whipple Co.* v. *Yale Clock Co.*, 123 U. S. 87.* In that case the various reissue statutes and the prior decisions dealing with the phrase were considered, and the conclusion was reached that the requirement that a reissue must be "for the same invention" means that a reissue must be confined to the invention which appears on examination of the original patent to be the invention intended to be covered or secured by the original patent (pp. 99, 102); or, stated in the words of the Court, to satisfy the requirement of the statute it must appear "from a comparison of the two patents, that the original patent embodied, as the invention intended to be secured by it, what the claims of the reissue are intended to cover" (p. 99). In disposing of the case before it, the Court said (p. 95):

> "The appellants contend that the first eight claims of the reissue do not specify any invention which is not contained in the clock described in the original patent and embodied in the model originally deposited in the Patent Office, and that the drawings of the original and of the reissued patent are substantially the same. On these premises, it is argued

* The specific facts of the *Parker & Whipple* case vary widely from those of the instant case. Cases presenting fact situations analogous to the instant case and applying the rule of the *Parker & Whipple* decision thereto are discussed *infra* pages 35 to 41.

for the appellants, that it is lawful to include in the claims of a reissue whatever is suggested, or substantially indicated, in the specification, model or drawings of the original patent, if the applicant was the original and first inventor thereof, and that such a reissue will, therefore, be for the same invention as that of the original patent.

"Expressions in some opinions of this court, wrested from their context and interpreted in a different sense from that in which they were used, are cited to support these views; but the language of the court on the subject *has steadily been to the contrary,* and, as the question arises so distinctly in this case, and some misapprehension exists in regard to it, it seems proper to discuss it with some fulness."

The Court proceeded to review the statutes and several decisions, including that in *Seymour* v. *Osborne* above cited, and then continued (pp. 98-99):

"In these extracts from the opinion it is seen that the court adheres strictly to the view, that, under the statute, the Commissioner has no jurisdiction to grant a reissued patent for an invention substantially different from that embodied in the original patent, and that a reissue granted not in accordance with that rule is void. In what is there said about redescribing the invention, and about including in the new description and new claims what was suggested or indicated in the original specification, drawings or patent office model, it is clearly to be understood, from the entire language, that the things so to be included are only the things which properly belonged to the invention as embodied in the original patent; *that what that invention was is to be ascertained by consulting the original patent;* and that, while the new description may properly contain things which are indicated in the original specifica-

> tion, drawings or patent office model, (though not sufficiently described in the original specification,) it does not follow that what was indicated in the original specification, drawings or patent office model is to be considered as a part of the invention, *unless the court can see, from a comparison of the two patents, that the original patent embodied, as the invention intended to be secured by it, what the claims of the reissue are intended to cover.*"

This Court has never departed from the rule announced in the *Parker & Whipple* case and has referred to that case with approval in many subsequent decisions, including *Matthews* v. *Ironclad Mfg. Co.*, 124 U. S. 347, 351; *Hoskin* v. *Fisher*, 125 U. S. 217, 223; *Yale Lock Co.* v. *James*, 125 U. S. 447, 464; *Flower* v. *Detroit*, 127 U. S. 563, 571; *Freeman* v. *Asmus*, 145 U. S. 226, 240; and *Corbin Cabinet Lock Co.* v. *Eagle Lock Co.*, 150 U. S. 38. In this last case, the Court said (pp. 42-3):

> "It is *settled* by the authorities that to warrant new and broader claims in a reissue, such claims must not be merely suggested or indicated in the original specification, drawings, or models, but it must further appear from the original patent that they constitute parts or portions of the invention which were *intended or sought to be covered or secured by such original patent.*"

Identity is to be Determined by Comparison of the Patents

It is thoroughly established that the issue of identity between what the inventor intended and attempted to cover in the original patent and what is claimed in the reissue patent is to be determined *by a comparison of the two patents.* Extrinsic evidence, except such as is needed to explain terms of art or to apply the descriptions to the subject matter, is excluded. The attempt of the inventor to secure patent pro-

tection for an invention covered by a reissue must be discoverable in the specification and drawings or model of the original patent. The cases in which this rule has been accepted and applied are in considerable number and include the following.

The rule was clearly stated in the *Parker & Whipple Co.* case discussed in our brief, *supra,* pages 29 and 30.

In *Seymour* v. *Osborne,* 11 Wall. 516, the Court said at pages 545-6:

> "Whether a reissued patent is for the same invention as that embodied in the original patent or for a different one is a question for the court in an equity suit to be determined as a matter of construction, *on a comparison of the two instruments,* aided or not by the testimony of expert witnesses, as it may or may not appear that one or both may contain technical terms or terms of art requiring such assistance in ascertaining the true meaning of the language employed."

In *Heald* v. *Rice,* 104 U. S. 737, the Court said on page 749 that this issue of "same invention" is one of "pure construction, and not of evidence; and consequently is matter of law for the court".

In *Ball* v. *Langles,* 102 U. S. 128, the Court said, page 130:

> "Accordingly, this court has repeatedly held that if, *on comparing a reissue with its original,* the former appears on its face to be for a different invention from that described or indicated in the latter, it must be declared invalid."

In *Freeman* v. *Asmus,* 145 U. S. 226, discussing whether a reissue was for the same invention as the original patent, the Court said (p. 239):

> "There is nothing *in the original specification* which indicates that any such claim was intended to be made in the original patent;"

See also the quotation *supra*, page 30, from the decision in the *Corbin Cabinet Lock Co.* case; and *Russell* v. *Dodge*, 93 U. S. 460, 464; *Garneau* v. *Dozier*, 102 U. S. 230, 231; *Manufacturing Co.* v. *Ladd*, 102 U. S. 408, 409; *Clements* v. *Odorless Apparatus Co.*, 109 U. S. 641; *Hoskin* v. *Fisher*, 125 U. S. 217, 221; *Dunham* v. *Dennison Mfg. Co.*, 154 U. S. 103.

Application of Established Principles to This Case

What appears from a comparison of the reissue patent and the original patent in this case (*supra*, pp. 5-10 and 14-18) may be summarized by the following quotations from the opinion of the Circuit Court of Appeals:

1. "the voluntary introduction of water was a mandatory provision of the original Lefort patent" (R. Vol. II, p. 176).
2. "the reissue patent does *not* contemplate the voluntary introduction of water" (R. Vol. II, p. 176).
3. "*there is a difference* here in that the original patent contemplated the voluntary introduction of water * * * as a step that would always be taken * * * while Claims #8 and #9 [of the reissue] contain no such requirement, and indeed seem to negative clearly any such step" (R. Vol. II, p. 177).

These findings are fully supported by an analysis of the patents.

The original patent contains no reference whatever, either in the specification or in the claims, to a process in

which the mixture subjected to contact with the catalyst in the reaction chamber is a mixture of ethylene and air only, nor any reference to a process in which water is not introduced into the reaction chamber (*supra,* pp. 5-10).

As to many of the individual items which make up the complete process, the original specification describes permissible alternatives, omissions and variations. But, though so much of the specification consists of a description of possible variations of the indicated procedure, it does not include any mention of or reference to a procedure in which no water is introduced into the reaction chamber along with the ethylene and oxygen, or in which no water is present in the reaction chamber other than that formed by the unavoidable side reaction (*supra,* p. 9).

Also, the claims define the process in terms which give appropriate recognition to the described alternatives, but the use of ethylene, oxygen *and* water either in the form of liquid or as steam, is called for by every claim (*supra,* pp. 9-10).

The instant case consequently is not one in which the process covered by the reissue is poorly or imperfectly stated in the original patent and in which the issue of intention is close. It is a case in which lack of intention is manifest since the process in question is not mentioned or referred to *at all* either in the specification or in the claims of the original patent.

The reissue simply omits from the process described and claimed in the original patent a process step—the introduction of water into the reaction chamber—made mandatory in the process originally claimed and intended to be patented. And so the Court below found. Had the lower Court applied to these facts this Court's interpretation of the statutory requirement, it could only have concluded that the

reissue patent was invalid. Instead, the Court of Appeals rested its decision upon an appraisal of the difference it had found to exist between the process intended to be secured by the original patent and the process covered by Claims 8 and 9 of the reissue patent, concluding that this difference was not "vital, essential, substantial or material" from the standpoint of technological results, and that therefore the reissue claims were valid.

The difference between the two patents found to exist by the Court of Appeals was not considered by that Court from the standpoint of the monopoly sought by the patentee in the original patent and obtained by his assignee in the reissue. Instead, it appears to have been considered only from the standpoint of the technological results obtained. The Court resolved the issue thus artificially created in favor of the respondent and thereon held the reissue patent valid.

The basis asserted by the Court below for this decision was the conclusion of respondent's expert witnesses that the difference between the two processes is not significant from a scientific point of view* since the same technological result can be obtained whether the method followed is that of the process disclosed in the original patent or that of the process disclosed and claimed in the reissued patent. In thus grounding its decision upon an evaluation of the difference between the process of the original patent and the process of the reissued patent in its purely technological aspect, the Court below departed from the rule of this Court that the intention of the patentee as it appears from the original patent is controlling.

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* The experts' testimony was characterized as being "from the technical viewpoint of chemistry," "from a scientific standpoint," or "speaking entirely as a chemist." (See Court of Appeals' opinion, R. Vol. II, pp. 180-1.)

The failure to accept this Court's interpretation of the statute led the lower Court into direct conflict with a group of decisions by this Court applying the principle of *Parker & Whipple* v. *Yale Clock Co.* to situations of identically the same nature as that presented here in which a patentee had attempted by reissue to make permissive a step described as mandatory in his original patent. Without exception these cases hold that the statutory requirement that a reissue must be "for the same invention" does not permit any step of a process, or any element of a device, made essential in an original patent to be made non-essential in a reissue. *Gill* v. *Wells*, 22 Wall. 1; *Collar Company* v. *Van Dusen*, 23 Wall. 530, 558; *Russell* v. *Dodge*, 93 U. S. 460; *Manufacturing Co.* v. *Ladd*, 102 U. S. 408, 413; *James* v. *Campbell*, 104 U. S. 356, 374; *Johnson* v. *Railroad Co.*, 105 U. S. 539; *McMurray* v. *Mallory*, 111 U. S. 97, 102; *Hoskin* v. *Fisher*, 125 U. S. 217, 222; *Cornell* v. *Weidner*, 127 U. S. 261, 264; *Farmers' Friend Mfg. Co.* v. *Challenge Corn-Planter Co.*, 128 U. S. 506; *Huber* v. *Nelson Mfg. Co.*, 148 U. S. 270; *Corbin Cabinet Lock Co.* v. *Eagle Lock Co.*, 150 U. S. 38, 42; *Olin* v. *Timken*, 155 U. S. 141, 146.

That rule has been applied by this Court in suits based on patents for processes, patents for manufactures, and patents for apparatus.

An instance of application of the rule in a suit on a process patent is *Russell* v. *Dodge*, 93 U. S. 460. There the original patent was for a process of treating bark-tanned skins by means of a compound in which *heated* fat liquor was explicitly made an essential ingredient. There was no disclosure that the fat liquor could be used cold. In the reissue, the specification was changed by eliminating the requirement that the fat liquor be in a heated condition. The Court held the reissue invalid, saying (p. 464):

> "The change made in the old specification, by eliminating the necessity of using the fat liquor in a heated condition, and making in the new specification its use in that condition a mere matter of convenience, and the insertion of an independent claim for the use of fat liquor in the treatment of leather generally, operated to enlarge the character and scope of the invention. The evident object of the patentee in seeking a reissue was not to correct any defects in specification or claim, but to change both, and thus obtain, in fact, a patent for a different invention. This result the law, as we have seen, does not permit."

An instance of application of the rule in a suit on a patent for a manufacture is *Collar Company* v. *Van Dusen*, 23 Wall. 530. There the original patent covered a shirt collar made of parchment-paper, or paper prepared with animal sizing, coated with a varnish of bleached shellac. There was no disclosure that the animal sizing could be omitted or that the varnish of bleached shellac could be dispensed with and yet the collar remain a useful and efficient article. The claims of the reissue patent, however, claimed a paper collar in which both the use of animal sizing and varnish were made permissive. The Court affirmed the dismissal of the bill, saying of the reissue patent (pp. 559-560):

> "Animal sizing, according to that patent, may be *used* or it may be *omitted*, and one or both sides of the paper may be covered with a thin varnish of bleached shellac or such a coating may be *omitted* altogether, which shows that those two requirements of the original patent are not a material part of the invention embodied in the reissued patent.
>
> Authorities to support the proposition that a reissued patent is invalid if not for the same invention as the surrendered original are scarcely neces-

sary as the rule is universally acknowledged." (Emphasis by the Court.)

Typical of many instances of application of the rule in suits on patents for apparatus is *Gill* v. *Wells*, 22 Wall. 1. There the original patent disclosed and claimed a machine for making hat bodies. One of the elements of the machine disclosed was a four-sided square tunnel or chamber interposed between the fur disintegrator and the rotating vacuum cone on which the hat body was formed. A current of air passing through this tunnel conveyed the fibres from the disintegrator brush to the cone. Nothing was said in the original specification to lead one to suppose that the tunnel could be dispensed with and yet the same result be obtained. The reissued patent claimed a machine from which the tunnel had been omitted. The Court held the reissue patent invalid. After pointing out that one who had fully described in his original specification several combinations of a varying number of elements, but had inadvertently failed to claim one of the described combinations, could remedy his mistake by reissue, the Court said (pp. 24-25):

> "Very different rules, however, apply in a case where the only invention described in the original patent is the one which includes all the ingredients of the machine, provided there is no suggestion, indication, or intimation that any other invention of any kind has been made. Such a patentee as the one last mentioned may subsequently discover that he can accomplish a new and useful result by a combination embracing less than the whole number of the ingredients included in the prior patented combination, but he cannot secure the right and privilege of a patentee in the combination of the smaller number of the ingredients by a surrender of his first patent and a reissue of the same which shall include the

second combination as well as the first, because the reissued patent in that event would not be for the same invention as the surrendered original."

And on page 26:

> "Patient search has been made in vain for any trace of the description of any other invention in the original patent than that of the combination of all the ingredients of the apparatus described by the patentee as the one used by him to effect the described patented result. Unable to discover in that specification any description of any other invention than that, the court is of the opinion that none other was secured by the original patent.
>
> *Argument to show that an invention consisting of a combination of three ingredients which are old is not the same as that of a combination of four old ingredients is quite unnecessary, as the negative of the proposition is as well settled in the patent law as it is in mathematics.*"

Another case in this same catagory is *Huber* v. *Nelson Mfg. Co.*, 148 U. S. 270. There the original patent was for a sanitary water-closet. In each of the six claims of the original patent and in the specification and drawing, a flushing chamber was included as an element of the combination defined. Although the original patent nowhere stated that the apparatus was operative in the absence of the flushing chamber, the specification of the reissue was altered to include a statement that the flushing chamber "has no function of its own," and claims were introduced to embrace a flushing apparatus like that covered by the claims of the original patent, *less* the flushing chamber. The Court held the statement that the flushing chamber "has no function of its own" to be "new matter," not suggested in the original patent, and sustained the defense

that the reissue was not for the same invention. The Court said (p. 291):

> "The entire text of the original specification shows nothing but the invention of a structure containing both a tank and a flushing-chamber. That chamber is referred to in the text of the original specification thirty-one times.
>
> We think that, on all the facts of this case, no one of the claims of the reissue can be construed as valid in leaving out the flushing-chamber as an element of the combination, inasmuch as every claim of the original patent contained it. *Prouty* v. *Ruggles*, 16 Pet. 336, 341; *Brookes* v. *Fiske*, 15 How. 212, 219; *Burr* v. *Duryee*, 1 Wall. 531; *Reckendorfer* v. *Faber*, 92 U. S. 347; *Fuller* v. *Yentzer*, 94 U. S. 288; *Railway Co.* v. *Sayles*, 97 U. S. 554; *Water-Meter Co.* v. *Desper*, 101 U. S. 332."

The lower courts have followed the interpretation of the Reissue Statute laid down by this Court. A list of cases is cited in the margin.* The representative case of *Featherstone* v. *George R. Bidwell Cycle Co.*, 57 Fed. 631, (C. C. A. 2) contains a particularly clear statement of the rule. That case involved a reissue patent for a bicycle tire.

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* *Featherstone* v. *George R. Bidwell Cycle Co.*, 57 Fed. 631 (C. C. A. 2d); *Toupet-Taylor Engineering Co.* v. *Red Dog Mfg. & Supply Co.*, 16 F. (2d) 454 (C. C. A. 3d); *Chicago Ry. Equipment Co.* v. *Perry Side Bearing Co.*, 170 Fed. 968 and 178 Fed. 449 (C. C. A. 7th); *McDowell* v. *Ideal Concrete Mach. Co.*, 187 Fed. 814 (C. C. A. 7th); *Penn Electric Switch Co.* v. *Luthe Hardware Co.*, 63 F. (2d) 842 (C. C. A. 8th); *Morgan* v. *Drake*, 36 F. (2d) 511 (C. C. P. A.); *Kollsman* v. *Carbonara*, 88 F. (2d) 966 (C. C. P. A.); *In Re Cogswell*, 48 F. (2d) 402 (C. C. P. A.); *In Re Williams*, 75 F. (2d) 520 (C. C. P. A.); *In Re French*, 89 F. (2d) 662 (C. C. P. A.); *In Re Overbury*, 95 F. (2d) 331 (C. C. P. A.).

In the specification and claims of the original patent certain "protective strips" were regarded as an essential part of the invention. In the reissue patent the claims were freed of this limitation. In considering the technological aspect of these strips the Court said (pp. 634-35):

> "It is obvious that the protective strips which are incorporated into the claim of the original patent, but which are omitted in the fourth claim of the reissue, are not an indispensable part of operative fastening devices for securing a pneumatic tire to the rim of the wheel. It is also obvious that they can be omitted from the fastening devices of Dunlop without rendering the other devices inoperative."

In spite of this finding that the strips were not a "vital, essential, substantial, material" element of the invention from a scientific point of view, the Court held the reissue patent invalid, saying (p. 636):

> "It has been repeatedly declared by the supreme court that a reissue cannot be permitted to secure any invention which was not described in the original patent; it is confined to securing one which was not only described, but which it was the intention of the patentee, manifest upon the face of the patent itself, to secure thereby. In other words, it must appear by the description in the original patent that it was the purpose of the patentee to secure the thing specified in the claim of the reissue, and a patent cannot be lawfully reissued unless there has been a clear mistake, inadvertently committed, in the wording of the claim."

The error of the Court below in holding that the difference between the process described and claimed in the original patent and the process described and claimed in the reissue must be ignored as immaterial because the final

result of the two processes is the same, is demonstrated by the cases just discussed. It is perfectly clear that in *Russell* v. *Dodge* the ultimate result of tanning the skins was accomplished whether the fat liquor was heated, as required by the original patent, or unheated, as disclosed in the reissue. Nevertheless, the Court held the reissue omitting this requirement to be void. Likewise, in *Huber* v. *Nelson*, the flushing chamber, claimed in the original patent in combination with the injector, was not in fact essential to its operation, the injector being able to perform its function as well with a single tank as with a tank and flushing chamber combined (148 U. S. 270, 289). Yet the reissue patent was held invalid. Similarly in *Gill* v. *Wells* the tunnel omitted in the reissue was not in fact necessary to the distribution of fur upon the revolving vacuum cone. But since the original patent contained no disclosure that it could be dispensed with (22 Wall. 1, 6) the reissue was declared void. In that case the Circuit Court fell into the same error as the Court below and its judgment of validity was reversed for the specific reason, among others (22 Wall. 1, 31):

> "That the Circuit Court erred in instructing the jury that the reissued patent is valid as respects the fourth claim if the combination of the three ingredients therein mentioned is new and could be usefully employed for the purpose of facilitating the making of hat-bodies * * * *if those three devices would make a hat-body without the aid of other means of protecting the fur against escape.*"

Without further specific example it is enough to point out that in all cases in which patents have been reissued to eliminate an element described as essential in the original patent, but which was in fact not essential, the results of the two processes or machines have always been substan-

tially the same. It is precisely because third parties can obtain or are obtaining the desired result without infringing the original patent that a reissue is obtained and suit is brought. Yet in every case of this kind brought to the attention of this Court the broadened reissue patent has been declared invalid as being not "for the same invention" as the original.

The point of all these decisions is that where a patentee asserts a step of a process as *mandatory,* as was found to be the fact here, he thereby makes it an essential part of his invention and a limitation on his monopoly. Having conceived the process as one in which that step is always to be taken and so informed the public in his original patent, he cannot thereafter reissue the patent to omit the step included in the original merely because afterthought or further investigation reveals that as a matter of scientific fact a similar result can be achieved even though the step be omitted.

The error of the Court below lay in failing to recognize from these cases that the difference between the two patents that has been held to be "vital, essential, substantial, material" under the statute is not the difference between the technological results obtained by the machines or processes disclosed, but is the difference in scope of the monopoly sought to be secured in the original patent and the monopoly asserted in the reissue.

This was also the error of the District Court, appearing very clearly in its Finding of Fact number 8 (R. Vol. I, p. 24; *supra,* p. 21) which was adopted by the Court of Appeals (R. Vol. II, p. 177). The statement in the District Court's opinion that "with respect to water, the specifica-

tions of the original patent are not essentially different from those in the reissued patent" (R. Vol. I, p. 9), and its Finding of Fact number 7, to the effect that "There is no variance" between the inventions described and claimed in the two patents (R. Vol. I, p. 24; *supra*, pp. 20-21), are somewhat obscure, as they appear to relate to the language of the patent rather than to the testimony of the experts. Nevertheless, they contain the germ of the same error, and were so interpreted by the Court of Appeals (R. Vol. II, p. 177).

The Court of Appeals assumed to find support for its decision in the case of *Seymour* v. *Osborne*, 11 Wall. 516 (R. Vol. II, p. 182). That case approves resort to the testimony of expert witnesses when the Court is determining, as a matter of construction, by comparison of the two instruments, whether the original and reissue patents are for the same invention. Such resort is approved for explanation of technical terms or terms of art in ascertaining the true meaning of the language employed. The Court of Appeals in the instant case did resort to the testimony of expert witnesses for that purpose (R. Vol. II, p. 176), and having done so, found without any hesitation that "*there is a difference* here in that the original patent contemplated the voluntary introduction of water into the reaction-chamber (distinguished from the mere formation of water during the course of the reactions) as a step that would always be taken in the procedure therein set out, while Claims #8 and #9 contain no such requirement, and indeed seem to negative clearly any such step" (R. Vol. II, p. 177).

The decision in *Seymour* v. *Osborne*, created no alteration in the established rule of this Court as to the proper

interpretation of the words "for the same invention" in the reissue statute.* That case does not in any way support the action of the Court of Appeals in the instant case in sustaining a reissue patent which, on the facts found by it, differs essentially from the original patent in respect to the scope asserted for its monopoly, merely because it has been established by expert testimony that the original limitation to the voluntary addition of water is not in fact essential to obtaining the desired result.

General Considerations

In the final section of the opinion of the Court below entitled "General Considerations," the Court asserts that the defenses set up by petitioner, including this defense that the reissue patent is not for the same invention as the original patent, are "terribly technical in the extreme" and "contain little or no appeal to the beneficent principles of equity and good conscience" (R. Vol. II, p. 186).

We submit that exactly the contrary is true.

The rule so long established and so consistently observed by this Court finds its origin in a determination to protect from abuse the beneficent purposes of the reissue statute; to preserve to the patentee, who has by inadvertence, accident or mistake, obtained a patent that is inoperative or insufficient to cover what he intended to claim as his invention, the right to correct his mistake by subsequent reissue, while at the same time guarding against any abuse of that privilege by which the monopoly originally contemplated

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* See this Court's comment on *Seymour* v. *Osborne* in *Parker & Whipple Co.* v. *Yale Clock Co.*, 123 U. S. 87 at p. 97.

is artificially enlarged. It is a just rule calculated to prevent a situation in which legitimate industry is subjected to hidden liens and unknown liability to vexatious lawsuits.

The reissue statute is a remedial and permissive statute. It extends to the patentee the unusual privilege of modifying his contract with the public to correct bona fide mistakes which have caused his assertion of monopoly to fall short of what he intended to claim. The requirement of the statute that the reissue be "for the same invention" is a fundamental statutory limitation upon this privilege, intended and well adapted, as it has been interpreted by this Court, to prevent abuse of the privilege. It is this restriction that separates the good from the bad, allowing the just claims of the inventor who has failed by inadvertence, accident or mistake to secure his intended monopoly, while barring the unjust claims of a patentee who seeks to extend his monopoly to cover discoveries, improvements, or developments which were not within his knowledge at the date of his application* or to which, if within his

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*In the instant case the evidence tends to establish that at the time of his original U. S. application, Lefort was not aware that the introduction of water could be dispensed with. The third of the series of French patents applied for prior to the U. S. application, and upon which the original U. S. application was based, makes specific claim to the *"necessity of introducing water vapor into the reacting gases"* to obtain ethylene oxide (R. Vol. I, pp. 371, 373). No change from this conception appears in the subsequent French patents until a year and a half after the U. S. patent had been applied for, when on July 10, 1933, the French company applied for a French patent directed to the discovery that *the introduction of water to the reacting gases could be dispensed with* (R. Vol. I, pp. 439, 440). It was not until after this French patent had been granted that application for reissue of the U. S. patent was filed by respondent.

knowledge at that time, he made no public assertion of right by disclosure and attempt to claim in his original patent.

That limitation imposed upon the remedial provisions of the reissue statute has most assuredly appealed to the "equity and good conscience" of this Court over a long period of years.

The Court below, on the basis of the considerations which it has set forth in its opinion and which we have discussed, has seen fit to attempt a breach in the well-established rule; to open therethrough a passage toward what the Court believed to be equity and good conscience, on evidence that in a scientific sense the newly monopolized process of the broadened claims is not different vitally, essentially, substantially or materially from the process monopolized by the original claims because the new process produces the same technological result as the old. We submit that through such a breach all of the evils which this Court has tried to shut out would pour. It is precisely because industry must remain free to produce by other processes the technological results of a patented process, that the rule has been adopted and enforced.

2. Petitioner has acquired intervening rights which render it inequitable to enforce against it the enlarged monopoly defined by claims 8 and 9 of the reissue.

One of the most vexing questions raised by the grant of reissue patents with broadened claims relates to the rights of innocent parties who, respecting the monopoly of an original patent, have evolved a non-infringing process or device only to find themselves subsequently in the position of infringers by reason of the unexpected appearance of a reissue with claims of broader scope than those of the original patent.

The inequity of this situation was early recognized in the law of reissue. Thus, in the case of *Miller* v. *Brass Company*, 104 U. S. 350, 355, it was pointed out that

> "* * * the evils which have grown from the practice [broadened reissues] have assumed large proportions. Patents have been so expanded and idealized, years after their first issue, that hundreds and thousands of mechanics and manufacturers, who had just reason to suppose that the field of action was open, have been obliged to discontinue their employments, or to pay an enormous tax for continuing them."

Again, in the case of *Dunham* v. *Dennison*, 154 U. S. 103, the Court, speaking through Mr. Justice GRAY, said at page 110:

> "The patentee thus gave the public to understand that an envelope, the flap of which did not cover its whole length, would not come within his patent, and might rightfully be made by anyone. After the defendant had made envelopes with a short flap of semicircular shape and covering little more than the opening of the envelope, (which, it is admitted, did not infringe the plaintiff's patent as originally issued,) the plaintiff obtained a reissue, enlarging the claims, and altering the specification throughout, so as to include an envelope with a flap of any size or shape, and to make the invention consist, not, as in the leading words of the description in the original patent, of 'an envelope with an end flap covering its side,' but in 'a tag provided with means for attaching it to the merchandise, and with an envelope or pocket to receive a bill or invoice of the merchandise.' The words of the description in the original patent were neither technical nor complicated; but they were of the simplest kind, and their meaning and scope could not have been misunderstood by anyone who read them with the slightest attention, least of all by the patentee. To uphold such a reissue under such circumstances would be to grant a new and distinct

privilege to the patentee at the expense of innocent parties, and would be inconsistent with the whole course of recent decisions in this court.' (Parenthesis by the Court.)

In these and in similar early cases, the reissued patents were held invalid on other grounds, the intervenor's plight being advanced as emphasizing the harmfulness of broadened reissues rather than as an ultimate ground of decision.

The question of intervening rights in connection with reissued patents was recognized by this Court as raising an important question of patent law which had not been but should be determined in *Keller* v. *Adams-Campbell Co.*, 264 U. S. 314, but no decision on the issue of intervening rights was rendered in that case.

Quite recently the issue of intervening rights came before the Court again in *Sontag Chain Stores Co.* v. *National Nut Co.*, 310 U. S. 281. In that case, this Court decided that where it appears that the defendant in a suit for infringement of a reissued patent began commercial use of the accused process or machine prior to the date of application for the reissued patent, then intervening rights accrue to him and injunctive relief against him should be denied the patent owner. The decision in that case was limited to the scope indicated. Being so limited, it left undecided by this Court whether or not intervening rights accrue to one who fully and completely develops a process or apparatus by prolonged and expensive research carried on prior to the grant of reissue, but does not initiate commercial operation until after the grant of the reissue. That question has never been decided by this Court.

In the instant case, petitioner's accused process was independently developed by petitioner's research engineers

in petitioner's own laboratories. The development of petitioner's process was completed and application for a patent covering inventions made in the course of the work was filed on May 8, 1937, a date prior to the grant of the reissue (R. Vol. I, pp. 224-5). The total expenditures of petitioner upon the development work from its inception to September 25, 1936, the date upon which the reissue application was filed, was approximately $132,000. Between September 25, 1936, and May 18, 1937, the date upon which the reissue was granted, an additional $19,000 was expended (R. Vol. I, p. 226). Throughout this development period, petitioner's technicians in charge of the research received and examined all pertinent literature as it was published, including the several French patents referred to in the foregoing and the original U. S. patent on which the reissue in suit is based (R. Vol. I, pp. 223; 196). That original U. S. Patent was granted April 23, 1935, so from that date on the research and development work was conducted with knowledge of the limitations of the monopoly of that patent.

The process so evolved by petitioner is not within the description of the original patent nor the claims of that patent, but it is within the description of the reissue patent and it is within the broader claims 8 and 9 added by the reissue. Nevertheless, the courts below refused to recognize petitioner's intervening rights on the ground that the work done before the reissue was granted was limited to experimental and development work (R. Vol. II, pp. 185-6).

In principle there appears to be no reasonable distinction to be drawn between the rights acquired by one who has made actual commercial use of a non-infringing device or process in reliance upon the limitations of an original patent, and one who, in the same reliance, has himself invented and perfected a non-infringing device or process. To deprive

the latter of the right to put the process so developed into commercial use deprives him of the fruits of his initiative as surely as to prevent an intervening manufacturer from continuing the use of the process or machinery he has installed in his factory. The inventor of a non-infringing process is in even worse case than the commercial user insofar as losses are concerned, for the user has at least obtained the benefits of his use prior to the reissue while the inventor must write off as a total loss the time, money, and energy invested in his development work if he is forbidden to seek any commercial return upon it. And certainly the expenditures in research and development work of the intervening inventor comprise vested interests of as positive a character as the commercial expenditures of the intervening manufacturer.

The issue stated in the foregoing was considered by the Court of Appeals for the Second Circuit in *Otis Elevator Company* v. *Atlantic Elevator Company*, 47 F. (2d) 545. In that case the court discussed the effect of experimental and development work carried on by the defendant between the date of the original patent and the broadened reissue thereof. With respect to the situation presented to it, the Court said (p. 548):

> "The installations at Los Angeles, Chicago and Pittsburgh were, it is true, experiments, and did not go into permanent operation, but they were steps forward. They involved considerable expense, whose fruition came later in the building at Cleveland, completed before the application was filed. We should not ignore them, because they were not used; the analogy of a prior use as anticipation is not apt. The question, on any view, is of the conflicting interests involved; the patentee's, to extend his monopoly; the public's, to be protected in vested rights acquired meanwhile. Earlier experiments, involv-

> ing large expense, and being the first steps in a continuous development which ends in a completed apparatus, are fairly to be taken as vested interests."

Although this *Otis* decision appears to be the only one relating directly to the question here presented, this Court, in the *Sontag* case, indicated that in approving the rule of intervening rights developed by the lower courts it had in mind not only the rights of the intervening manufacturer, but of the intervening inventor as well. Thus the Court said (pp. 293-4):

> "Recapture within two years of what a patentee dedicates to the public through omission is permissible under specified conditions, but not, we think, 'at the expense of innocent parties.' Otherwise, the door is open for gross injustice to *alert inventors* and baffling uncertainty will hinder orderly development of useful arts."

This statement is particularly apt in view of the modern industrial background of invention. The Court can take judicial notice of the fact that a large proportion of the industrial improvements developed in recent years has evolved from protracted research conducted at great expense. The ultimate object of such research is not merely to produce patentable inventions, but to employ those inventions in commercial operations. Under these conditions, where extensive development work of an experimental nature involving years of time and large expenditures of money necessarily precedes commercial operations, the restriction of intervening rights to those alone who have actually reached the stage of commercial operation prior to the reissue would work great harm. In any field in which there existed a patent which could conceivably be reissued with an enlarged monopoly, the risk involved

in financing further research and development work would create an overpowering obstacle to "alert inventors." With no prospect of protection against enlarged reissues until after the invention has been put into commercial operation, a step which involves a cost far greater than that required for the development work itself,* the risk of loss becomes entirely disproportionate to the opportunity for profit, and the progress of science and useful arts in that field is correspondingly delayed. It is only by recognizing the expenditure of time, effort, and money in the development work itself that the tremendous modern investment in research and development of improved industrial processes, upon which the progress of modern industry so largely depends, can be secured and protected.

Industrial Importance of the Lefort Process

The Court of Appeals laid considerable emphasis upon the industrial importance of the direct oxidation process. The Court said that a French inventor "made a discovery of great scientific importance and unquestioned commercial value" resulting in a process which "provided a practical and original solution to a problem that had long baffled industrial chemists" (R. Vol. II, p. 186).

It is clear that although such considerations have a legitimate bearing on questions of patentability, they cannot properly affect the determination of the questions of reissue law presented by this case. The lower Court's opinion, nevertheless, does reveal fairly plainly that it was influenced by sympathy for the patent even in its interpretation of the reissue statute. This sympathy was

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* Petitioner's Baltimore plant cost more than $1,000,000 (District Court's opinion, R. Vol. I, p. 20).

misplaced factually, as well as legally. In point of fact the evidence of the record does not support the contention of industrial importance which influenced the Court.

Respondent offered no evidence of anything done by the patentee or the French company in practicing the process described in the original patent and no evidence of any commercial achievement in utilizing that process. Such evidence as there is in the record was offered by petitioner and indicates that the process of the original patent is not useful commercially (Pyzel, R. Vol. I, pp. 32-70; de Jong, R. Vol. I, pp. 70-89; Deft's. Exs. 42-3, 46-61, 64, R. Vol. I, pp. 385-426).

Petitioner's process and that of the respondent, two processes developed in the United States each independently of the other, are processes which are important and have "unquestioned commercial value." *Those two processes do not involve the introduction of water into the reaction chamber along with the ethylene and air.* Therefore, neither of those processes is the process of the original patent. They are different processes which are within the reissue specification and within the broader claims of the reissue only because of the respects in which the specification and claims of the reissue are different from the specification and claims of the original patent.

These being the facts as disclosed by the record, it is wholly illusory to find importance and value in the process described in the original patent by reason of any measure of success attained by petitioner and respondent in the use of their different processes.

An analogous situation has been the subject of comment by this Court quite recently in the concurring opinion of the Chief Justice in *Cuno Engineering Corporation* v. *Automatic Devices Corporation*, 86 L. Ed. 21; 51 U. S. P. Q. 272.

In that case the commercially successful device for which the respondent claimed credit was not the device described in the patent in suit and the Court pointed out that consequently any favorable deduction which might be drawn from such success could not apply to the patent under consideration. Here the Court of Appeals appears to have found some justification for the enlargement of the monopoly of the original patent by reissue because of the success of a process which is not that described in the original patent and is within the description of the reissue only by reason of the changes in the description made in the process of reissuing. That proposition can be accepted no more readily than the respondent's claims in the *Cuno* case.

Conclusion

We submit that the record here discloses a plain case of error of the lower courts and that the error should be rectified by remanding the case with instructions to enter a decree holding the two broadened claims of the reissue patent to be invalid, and further that if they were valid this petitioner should be free to use the process which it developed at great expense prior to the grant of the reissue.

Respectfully submitted,

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DEAN S. EDMONDS,
W. PETERS BLANC,
Of Counsel.

Dated: February 11, 1942.

APPENDIX

Reissue Statute

R. S., SEC. 4916. (U. S. C., Title 35, Sec. 64.) Whenever any patent is wholly or partially inoperative or invalid, by reason of a defective or insufficient specification, or by reason of the patentee claiming as his own invention or discovery more than he had a right to claim as new, if the error has arisen by inadvertence, accident, or mistake, and without any fraudulent or deceptive intention, the commissioner shall, on the surrender of such patent and the payment of the duty required by law, cause a patent for the same invention, and in accordance with the corrected specification, to be reissued to the patentee or to his assigns or legal representatives, for the unexpired part of the term of the original patent. Such surrender shall take effect upon the issue of the reissued patent, but in so far as the claims of the original and reissued patents are identical, such surrender shall not affect any action then pending nor abate any cause of action then existing, and the reissued patent to the extent that its claims are identical with the original patent shall constitute a continuation thereof and have effect continuously from the date of the original patent. The commissioner may, in his discretion, cause several patents to be issued for distinct and separate parts of the thing patented, upon demand of the applicant, and upon payment of the required fee for a reissue for each of such reissued letters patent. The specifications and claims in every such case shall be subject to revision and restriction in the same manner as original applications are. Every patent so reissued, together with the corrected specifications, shall have the same effect and operation in law, on

the trial of all actions for causes thereafter arising, as if the same had been originally filed in such corrected form; but no new matter shall be introduced into the specification, nor in the case of a machine patent shall the model or drawings be amended, except each by the other; but when there is neither model nor drawing, amendments may be made upon proof satisfactory to the commissioner that such new matter or amendment was a part of the original invention, and was omitted from the specification by inadvertence, accident, or mistake, as aforesaid.

Patented Apr. 23, 1935

1,998,878

UNITED STATES PATENT OFFICE

1,998,878

PROCESS FOR THE PRODUCTION OF ETHYLENE OXIDE

Théodore Emile Lefort, Paris, France, assignor to Société Anonyme; Societe Francaise de Catalyse Generalisee, Paris, France

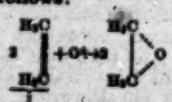
No Drawing. Application March 22, 1932, Serial No. 600,578. In France March 27, 1931

7 Claims. (Cl. 260—156.5)

REISSUED

This invention has for object a process for the production of ethylene oxide which mainly consists in subjecting ethylene to the simultaneous action of the oxygen of air and of water, in presence of a catalyzer and, if need be, of hydrogen.

Hydrogen, in case it is employed, in contact with the catalyzer, probably plays the part of an agent for accelerating the reaction which can be written as follows:



This reaction takes place at atmospheric pressure but, for commercially carrying the said process into practice, pressure can be employed, for instance a pressure of 50 kilograms per square centimeter, at a temperature between 150 and 400° C.

The following catalysers may be used:

(1) A mixture of antimony, bismuth, silver, lead, arsenic, nickel and tin, in variable proportions.

(2) Silver alone.

(3) Silver activated by introducing therein small proportions of gold, copper or iron.

(4) The metals: gold, copper, iron, separately or in admixture and in any proportions.

(5) Silver alone, bismuth alone and antimony alone.

(6) The following mixtures:

Silver, gold, copper, iron	in any proportions
Silver, gold, copper	
Silver, gold	
Silver, copper, iron	
Silver, copper	
Silver, iron	
Copper, iron	

(7) The mixtures of antimony, lead, nickel and silver.

(8) The mixtures of bismuth, nickel, silver and lead.

(9) The mixtures of antimony, bismuth, nickel.

(10) The mixtures of antimony, bismuth, silver.

(11) The mixtures of bismuth and nickel.

(12) The mixtures of bismuth and silver.

And, generally speaking, all the mixtures which can be obtained with the following metals: antimony, lead, bismuth, silver, nickel, tin, arsenic, gold, copper, iron, taken separately, taken two by two, three by three, four by four, etc. . . . in variable proportions, the mixtures, in the same conditions, of these metals with their oxides, the mixtures of the oxides alone of these metals, in the same conditions.

The ethylene can be obtained from any source of supply: gas from coke ovens, hydrogenation of acetylene, dehydration of ethyl alcohol, and the like.

Water can be admitted in the reaction vessel, either in the liquid state, or as steam.

The oxygen can be the oxygen of the air, this latter gas being introduced in the reaction.

The efficiency of the reaction is increased by diminishing the CO_2 which is formed, by introduction, in this reaction, of a suitable quantity of water. A suitable volume of CO_2 can also be previously introduced in the reacting gases.

For increasing the yield in ethylene oxide, the process can also be carried out under a pressure lower than atmospheric pressure.

Experiments have shown that silver could be activated by introducing, in this body, small quantities either of gold, or of copper, or of iron.

Thus, a mixture containing silver, gold, copper and iron, gives very satisfactory results and allows a specific reaction; the only foreign product obtained in the reaction is CO_2 which can be easily removed. Aldehydes formed exist only as traces.

Moreover, the applicant has found that the reaction giving CO_2 is, contrarily to previous belief, a reaction of oxidation independent from that giving ethylene oxide and from that giving aldehydes. From experiments effected by the applicant, it results that, if water is introduced in suitable quantity, the reaction is not only facilitated, as above stated, but, in addition, the reaction giving CO_2, probably by direct oxidation of ethylene according to the equation:

$$C_2H_4+3O_2=2H_2O+2CO_2$$

is checked, owing, as is probable, to the partial pressure of water. From these experiments, it can be concluded that if a certain quantity of CO_2 is previously introduced, in addition, in the reacting gases, the partial pressure of CO_2 will produce its effect, and the reaction of oxidation of ethylene into CO_2 will be completely checked resulting in a considerable increase in the efficiency of the operation. Moreover, it is to be noted that, when the synthetic operation is effected under partial vacuum, the yield in ethylene oxide is increased.

Several modi operandi for carrying the process

into practice, will be indicated hereinafter, by way of example only.

Modus operandi I

In a plant constructed for resisting to high pressures, ethylene on the one hand, and air on the other hand, are separately compressed by means of suitable compressors.

The mixture of air and ethylene can also be compressed by taking the necessary precautions in order to avoid the risk of explosion.

These two gases will be led, together with hydrogen or not, into a reaction tube resisting to the pressure of several hundreds of kilograms, containing one of the catalyzers indicated above, and heated, for instance, to a temperature of 200° C. This tube communicated moreover with a circulating pump allowing to introduce water under pressure.

The reaction will take place in this tube between ethylene, the oxygen of air, and water. By controlling the outputs, a continuous operation will be obtained. Ethylene oxide thus formed will be separated from the other gases, for instance, by condensation.

Modus operandi II

Silver in powder form, or in the form of a wire ...ure, and placed or not on a support or carrier, is introduced in a tube, made for instance of silica, and, after the said tube has been heated to a temperature comprised between 150 and 400° C., a mixture of ethylene, air, water vapour, and hydrogen is caused to pass therethrough. The proportion of hydrogen is about 5% of the total mixture. The ethylene oxide produced can be separated from the gases issuing from the tube.

Modus operandi III

A silver colloid is introduced in a high pressure tube which has been filled with water. Pure ethylene under pressure is then added in order that it can dissolve in the water.

The tube is subsequently heated between 150 and 400° C., then air and hydrogen are slowly introduced. The introduction of air is stopped when the totality of ethylene is converted into ethylene oxide.

From ethylene oxide produced according to the processes which have been indicated above, it is possible to obtain, by simple saponification, ethylene-glycol, or by other known methods, any derivative of ethylene-glycol.

The reaction, for obtaining ethylene-glycol, can be written as follows:

$$C_2H_4O + H_2O \rightarrow \begin{matrix} H_2C-OH \\ | \\ H_2C-OH \end{matrix}$$

The experiments effected by the applicant have shown that, in presence of the catalyzers indicated, water, in the form of steam or not, considerably promotes the reaction ensuring the production of ethylene oxide.

What I claim as my invention and desire to secure by Letters Patent is:

1. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, in presence of a catalyst, constituted by silver activated by introducing in the body small quantities of a metal selected from a group consisting of gold, copper, and iron, at a temperature between 150 and 400° C.

2. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of the oxygen and water, in presence of a catalyst, constituted by a mixture of silver, gold, copper and iron, at a temperature between 150 and 400 degrees C.

3. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, in presence of a catalyst constituted by a mixture of silver and gold, at a temperature between 150 and 400° C.

4. A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen and steam, in presence of a catalyst constituted by a metal selected from a group consisting of silver, gold, copper and iron, and hydrogen in the proportion of 5 per cent of the total volume, at a temperature between 150 and 400 degrees C., and at a pressure below atmospheric pressure.

5. A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen and steam, in presence of a catalyst constituted by a metal selected from a group consisting of silver, gold, copper and iron, and hydrogen in the proportion of 5 per cent of the total volume, and CO_2, and at a pressure below atmospheric pressure.

6. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen, steam and hydrogen in presence of a catalyst constituted by silver activated with small quantities of gold, at a temperature between 150 and 400 degrees C.

7. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen, steam and hydrogen in presence of a catalyst constituted by silver activated with small quantities of a mixture of gold and copper at a temperature between 150 and 400 degrees C.

THÉODORE EMILE LEFORT.

Reissued May 18, 1937

Re. 20,370

UNITED STATES PATENT OFFICE

20,370

PROCESS FOR THE PRODUCTION OF ETHYLENE OXIDE

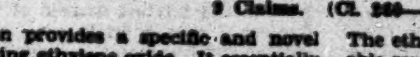
Theodore Emile Lefort, Paris, France, assignor, by mesne assignments, to Carbide and Carbon Chemicals Corporation, New York, N. Y., a corporation of New York

No Drawing. Original No. 1,998,878, dated April 23, 1935, Serial No. 668,578, March 12, 1932. Application for reissue September 25, 1936, Serial No. 102,813. In France March 27, 1931

9 Claims. (Cl. 260—54)

This invention provides a specific and novel process for making ethylene oxide. It essentially consists in causing ethylene to combine directly with molecular oxygen at temperatures of about 150° to about 400° C. in the presence of a surface catalyst which favors the oxidation of ethylene to ethylene oxide under these conditions. The process can be carried out at atmospheric pressure, and it may also be conducted at pressures above or below atmospheric pressure.

This process is characterized by an entirely unique reaction in which the direct addition of a single oxygen atom to the ethylene molecule occurs without the formation of significant amounts of other oxygenated compounds such as aldehydes. This novel reaction may be expressed as:



and it is accompanied by complete oxidation of some of the ethylene to give carbon dioxide and water according to the equation:

$$CH_2{=}CH_2 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

Ethylene from any desired source may be used, including that obtained from coke oven gas, hydrogenation of acetylene, or dehydration of ethyl alcohol. The oxygen can be the oxygen of the air, and can conveniently be mixed with the ethylene prior to the reaction.

The oxidation of ethylene takes place with a giving off of heat, and it is, of course, desirable to maintain the temperature of the zone of reaction within the range specified. This can be facilitated by suitable dilution of the reaction gases, such as that accomplished by the use of air as the source of oxygen, and some water or carbon dioxide in addition to that formed can be admitted to the mixture in the reaction zone if desired. Hydrogen may be similarly added.

The process can be conveniently conducted by passing a mixture containing air and ethylene through a tube, for example, of silica or of a material capable of withstanding high pressures, within which is placed such a surface catalyst as one composed of silver in finely divided form, and which may be disposed within the tube on a supporting material, or in other known ways. The temperature of the reaction zone is maintained between about 150° and about 400° C., for example, at about 200° C., and the issuing products from the tube contain ethylene oxide, carbon dioxide and water without objectionable aldehydes.

The ethylene oxide can be recovered in any suitable way, preferably in liquid form by condensation or solution.

The surface catalyst is preferably silver as stated, but other metals such as bismuth and antimony may be used. Likewise oxides of these metals or mixtures containing these metals or their oxides may be used. Experiments have also indicated that the catalyst may be silver activated by the addition of small amounts of gold or copper or iron.

In any case, the ethylene and oxygen are thus reacted simultaneously at the temperatures set forth in the presence of a surface catalyst and of water, and the process is conducted to produce ethylene oxide as a direct product in substantial and economic amount. The ethylene oxide can be recovered by known methods, and it may be further reacted to form ethylene glycol or derivatives of ethylene glycol.

I claim:

1. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water at a temperature between 150° and 400° C. in the presence of a catalyst composed of silver activated by small quantities of a metal selected from a group consisting of gold, copper and iron.

2. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of the oxygen and water at a temperature between 150° and 400° C. in the presence of a catalyst composed of a mixture of silver, gold, copper and iron.

3. A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water at a temperature between 150° C. and 400° C. in the presence of a catalyst composed of a mixture of silver and gold.

4. A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen and steam at a temperature between 150° and 400° C., and at a pressure below atmospheric pressure, in the presence of a catalyst composed of a metal selected from a group consisting of silver, gold, copper and iron, and in the presence of hydrogen in the proportion of 5 per cent of the total volume.

5. A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen and steam at a pressure below atmospheric pressure, in the presence of a catalyst composed of a metal selected from a group consisting of silver, gold, copper

and iron, and in the presence of hydrogen in the proportion of 5 per cent of the total volume, and of CO_2.

6. A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen, steam and hydrogen at a temperature between 150° and 400° C. in the presence of a catalyst composed of silver activated with small quantities of gold.

7. A process for the production of ethylene oxide consisting in subjecting ethylene to the simultaneous action of oxygen, steam and hydrogen at a temperature between 150° and 400° C. in the presence of a catalyst composed of silver activated with small quantities of a mixture of gold and copper.

8. The process of making ethylene oxide by the direct chemical combination of oxygen with ethylene in the proportions of one atom of oxygen to one molecule of ethylene, which comprises forming a mixture containing ethylene and molecular oxygen and conducting said mixture through a confined reaction zone which is maintained at an elevated temperature; controlling said temperature to maintain said mixture in said zone at a temperature between about 150° and about 400° C.; subjecting said mixture in said zone at said elevated controlled temperature to intimate contact with an active surface catalyst of a material having the catalytic characteristics of silver which favors the direct oxidation of said ethylene in said mixture by said molecular oxygen to form oxidation products containing ethylene oxide in the presence of water and which does not favor the existence in said products of substantial amounts of aldehydes; correlating the passage of said mixture through said reaction zone in the presence of said catalyst and the controlled elevated temperature of said mixture and said catalyst to effect said oxidation of said ethylene directly to form substantial amounts of ethylene oxide; and thereafter recovering ethylene oxide-containing product in liquid form.

9. The process of making ethylene oxide by the direct chemical combination of oxygen with ethylene in the proportions of one atom of oxygen to one molecule of ethylene, which comprises forming a mixture containing ethylene and molecular oxygen and a heat-absorbing diluent and conducting said mixture through a confined reaction zone which is maintained at an elevated temperature; controlling said temperature to maintain said mixture in said zone at a temperature between about 150° and about 400° C.; subjecting said mixture at said elevated controlled temperature to intimate contact with an active surface catalyst material composed essentially of silver which favors the direct oxidation of said ethylene in said mixture by said molecular oxygen to form oxidation products containing ethylene oxide in the presence of water and which does not favor the existence in said products of substantial amounts of aldehydes; correlating the passage of said mixture through said reaction zone in the presence of said catalyst and the controlled elevated temperature of said mixture and said catalyst to effect said oxidation of said ethylene directly to form substantial amounts of ethylene oxide; and thereafter separating ethylene oxide from the products of oxidation.

THEODORE EMILE LEFORT.

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FILED
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IN THE

Supreme Court of the United States

OCTOBER TERM, 1941

No. 680.

U. S. INDUSTRIAL CHEMICALS, INC., *Petitioner,*

v.

CARBIDE AND CARBON CHEMICALS CORPORATION, *Respondent.*

On Writ of Certiorari to the United States Circuit Court of Appeals for the Fourth Circuit.

REPLY BRIEF FOR PETITIONER.

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REPLY BRIEF FOR PETITIONER.

The "Same Invention."

The major premise of respondent's brief is that the Lefort *reissue* patent, as well as the original patent, *makes mandatory* the voluntary introduction of some water to the reaction chamber, in addition to the water therein produced by the side reaction. This mandatory introduction respondent now finds to be satisfied by the moisture content of air.

Respondent's position is summarized at pages 17 and 18 of its brief as follows:

> "In *both* of the patents the presence in the reaction chamber of the necessary water and the necessary oxygen, *and the mandatory introduction of both*, is effected by the introduction of *air* * * *. It is apparent, therefore, that the presence of the necessary water in the reaction chamber, *as well as its introduction thereto*, is just as mandatory *in the reissue patent* as it is in the original."

This new interpretation of the patents, now brought forward for the first time, is a repudiation of the findings of the Fourth Circuit Court of Appeals, which held that (1) "the voluntary introduction of water was a mandatory provision of the original Lefort patent", and that (2) *"the reissue patent does not contemplate the voluntary introduction of water"* (R. Vol. II, page 176.).*

By thus repudiating the findings of the Circuit Court of Appeals on this crucial question, respondent seems to avoid all need to defend the erroneous procedure of that court which lies in resting its decision upholding the reissue patent notwithstanding this difference on expert testimony to the effect that the same technological result is obtained whether the additional water is used or omitted.

Respondent's brief contains no discussion of that erroneous procedure, and perhaps we may assume that silence gives consent to the point elaborated in our principal brief

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* In the Court below; respondent read the reissue patent in the same way that the Court of Appeals read it, regarding the introduction of water as optional, not mandatory in the reissue; but respondent then argued that the reissue did not differ from the original because the original also, respondent said, made the introduction of water an optional step.

In respondent's brief in opposition to the petition for certiorari in this Court, respondent's counsel said on page 5, "On the contrary, as pointed out above, the introduction of water, as distinguished from its presence, in the reaction zone is *not* 'an essential feature' in the invention at bar, and was *not* 'described and claimed in the original patent as an essential feature'."

that such procedure flies in the face of a long line of decisions of this Court.

Respondent's new interpretation of the disclosure of the reissue patent, in direct conflict with the finding of the Circuit Court of Appeals, finds no support in the decision of the trial court. The trial judge in his opinion and findings by-passed the crucial question whether the reissue patent differs from the original patent in an intention to make the voluntary addition of water optional, instead of mandatory.

Without regard to the rule of this Court that the patentee's intention is of controlling importance, the trial judge erroneously rested his decision on expert testimony "that one skilled in the art, following the teachings of the original patent, will be successful in producing what that patent calls for, and in obtaining such result whether the addition of water be considered as mandatory or as optional". (Findings 8, R. Vol. I, page 24.)

It is obvious that this test of identity, thus erroneously applied by the trial judge, and, following him, by the Court of Appeals, would have resulted in validating the reissue if applied in any of the cases discussed in our principal brief in which this Court has invalidated the reissued patent. (See our Principal Brief, pages 35-42.)

We have said that respondent's new interpretation of the original patent "seems" to avoid the necessity for discussing this error of law, but respondent's argument *only seems* to avoid that necessity. It does not avoid it in fact, because in the development of the argument respondent's counsel states (see page 14) that "whether or not claims 8 and 9 are for the same invention as that of the original patent is a simple question of *fact* on which both the District Court and the Court of Appeals are in complete accord." (Emphasis theirs.)

But the thing upon which the District Court and the Court of Appeals were in accord was not "a simple question of fact", it was an erroneous conclusion of law which resulted from the fact that both Courts, disregarding

the rule of this Court, answered the question whether the original patent and the reissue were for the same invention, not by direct comparison of the two documents to ascertain the intention of the patentee, but by reference to extraneous expert testimony as to the technological result of using or omitting to use the step which the original patent made mandatory and the reissue made optional.

Since respondent's counsel now make this new interpretation of the reissue patent the major point of their case, we make the following remarks about it:

1. If it were admitted, as it is not, that the original patent disclosed or attempted to claim a process in which the introduction of air not previously dried satisfied the mandatory requirement of the addition of water to the reaction gases, it is clear that the reissue patent does not make even that minute addition of water mandatory. In its disclosure and in its claims it definitely embraces a process in which no water is added.*

The specification and claims of the reissue patent call simply for the introduction of "molecular oxygen" to the reaction chamber. No expression could be more aptly chosen to include a process in which the oxygen is introduced in the pure, and dry, state instead of being introduced as air. The requirement of the reissue claims 8 and 9 that the reaction shall be carried out in the presence of a catalyst which favors the direct oxidation of ethylene "in the presence of water" is fully satisfied by a process in which no water whatever is added, either as liquid, steam or in the air, since the oxidation of the ethylene is accompanied by the side reaction which always assures the presence of water in the reaction zone. Thus, the reissue patent includes, and was intended to include, within its monopoly a process in which no water is introduced into the reaction chamber either as

* It is, of course, understood that in any case water is inevitably produced chemically in the reaction zone by the side reaction which accompanies the oxidation of ethylene to ethylene oxide.

moisture in the air or as steam or in the liquid state. It is precisely this enlargement of the monopoly beyond anything contemplated or intended in the original patent that makes the reissue invalid.

2. The factual assertion upon which respondent's new interpretation is predicated is that the addition of some water is essential to cause the reaction to occur, and that the moisture content of air is sufficient for that purpose. (Respondent's Brief, pages 6-7.)

Counsel say it is "a fact conceded in this case (Petitioner's Brief, p. 18; see also R. II, p. 81) that the water in air is sufficient to cause the reaction to occur," and on page 10 of their brief say "Concededly a factor *essential* to *cause* oxygen and ethylene to combine, is the *presence of water*"; and on page 15 "*In both* the original and reissue patents the necessity for the presence of water to *cause* the desired reaction is expressly recorded". (Emphasis theirs.)

There is no such concession in our brief, and the reference to Vol. II of the record at page 81 or elsewhere does not support the factual assertion. At that page Dr. Frazer said that "there must be a little water in the reactants to start the reaction, because, if the statement in the patent is true—I have never tried it—if the gases are entirely dry you get no reaction". *There is no statement* in Lefort's original patent, or in the reissue, that if the gases are entirely dry you get no reaction, and there is no evidence to that effect in the record. The patent referred to by Dr. Frazer is not identified in the record.

Indeed, as to the effect of water in the reaction zone Dr. Taylor said (R. Vol. 1, page 121) "Well, of course, one's answer to a question of that kind must be, of course, largely speculative. . . . I would say that the effect of the water resides probably in the fact that it is a partaker with the other two constituents of the sites on the surface [of the catalyst] which are available for reaction." Dr. Ryerson (R. Vol. 1, pages 135-136) testified that in his opinion ethylene oxide without aldehydes would be produced by the re-

action whether or not the entering gas mixture had been dried; and, referring to the statement of invention in the second sentence of the first paragraph of the reissue patent he said, "There is no mention of water in that particular paragraph and it mentions molecular oxygen, which in my opinion, means you could use dry oxygen. It does not have to come from the air." (R. Vol. II, p. 93) And, finally, he said that "The two patents differ in the requirement of what shall be present when the reaction occurs. The statement [referring to molecular oxygen] gives no evidence of what is happening on the catalyst surface, and that must be speculation." (R. II, p. 103). Respondent's own technical staff ran a series of tests in which neither liquid water nor steam was introduced to the chamber and in which the water vapor content of the entering gases was reduced to *two one thousandths of one per cent.* (R. Vol. II, pp. 52-53; 159). This is two thousandths of the average water vapor content of air (R. Vol. II, p. 122). The reaction is continued unaffected. (R. Vol. II, p. 159). Respondent's expert Stevenson, pointing out that the side reaction which forms water results in the presence of water in the reaction zone always, said that the main reaction always goes on "in the presence of water" but "the air can be dry". (R. Vol. II, p. 17) And again, in answer to a question by the Court, he testified that "The reaction does take place" whenever water is present "from whatever source, water occurring in the air or deliberately put in *or formed in the reaction zone on the job.*" (R. Vol. II, p. 35), and in explaining his view of the reissue patent to the Court he said "I would like to show that in the reissue patent *it is not mandatory* for the addition of water to the entering gases, *but optional.*" (R. Vol. II, p. 36, emphasis ours) Respondent's expert Curme, when asked if he knew "What takes place at the surface of the catalyst when you have present ethylene, oxygen and a large proportion of steam" said "From the standpoint of actual knowledge, no one knows. There are many engaging theories . . . but . . .

there is no absolute knowledge on this subject." (R. Vol. II, p. 63)

3. The original patent nowhere mentions the water vapor content of air and nowhere states that the moisture content of air is effective in the process in any degree. The patent thus contains no disclosure of the basic fact on which respondent's theory rests.

Respondent attempts to read the expression "oxygen of air and of water" in the original patent as though it read "oxygen and water of air" (Respondent's Brief, pp. 6 and 19). It *does not* read that way, and to change it in that way would be a departure from the original disclosure in the direction of new matter, which the reissue statute forbids.

The patent states that the forms in which water can be introduced to the reaction chamber "are either in the liquid state, or as steam" (1/2/11). In perfect conformity with this statement, wherever water is referred to in the patent it is referred to in one of these forms. There is no mention in the original patent, either in the specification or in the claims, of a process in which the mixture subjected to contact with the catalyst in the reaction chamber is a mixture of ethylene and air only. On the contrary, wherever it is directed that air be introduced to the reaction chamber it is directed that water in the liquid state or as steam must be introduced as well. (See our Main Brief, pp. 5-10 and 22-3.)

4. The patent nowhere discloses the possible utility of water in the minute quantities which constitute the moisture content of air. On the contrary, it indicates that the introduction of water in substantial quantities is required. Thus, in *Modus Operandi I*, the reaction chamber communicates with a *circulating pump* which introduces water under pressure to the tube where the reaction takes place "between ethylene, the oxygen of air, and water" (2/1/5-25). Similarly in *Modus Operandi III* it is directed that the reaction tube be "filled with water" (2/1/42).

Evidence in the record discloses the same fact. Before respondent acquired the Lefort patent, the Royal Dutch Shell Company spent months investigating the process with a view to purchase. In their investigation they had the cooperation of the French company to whom all the Lefort patents had issued. The process was performed in the French company's laboratories for the instruction of Dutch Shell's technical representatives. In all cases large amounts of steam were introduced to the reaction chamber, never running lower than *50 per cent of the total mixture of gases* (R. Vol. I, p. 49).

5. Finally, petitioner takes the position "That there is complete identity of the invention *claimed* by the original patent and that recited in claims 8 and 9 of the reissue" (page 15) and that "The *only* difference between them is a change in the designation of the catalyzer" (page 16).

We think it will be very difficult for respondent's counsel to convince this Court that the subtle and ingenious wording of the reissue claims 8 and 9 was intended only to monopolize for the owner of the patent the use of a particular class of catalysts, regardless of the voluntary addition or omission of water.

If that had been the purpose of the reissue, respondent could have achieved it by adding to the original patent a claim exactly like original claim 1 with the substitution for the words "a catalyst, constituted by silver activated by introducing in the body small quantities of metal selected from a group consisting of gold, copper and iron" of the original claim, the words of reissue claim 8, "an active surface catalyst of a material having the catalytic characteristics of silver which favors the direct oxidation of said ethylene in said mixture by said molecular oxygen to form oxidation products containing ethylene oxide in the presence of water and which does not favor the existence in said products of substantial amounts of aldehydes."

Such a substitution would have achieved the purpose of broadly defining the catalyst, which respondent now pre-

tends to be the purpose of the reissue, but it would have left the voluntary introduction of water as it was defined in the original specification and in the words of the original claim "subjecting ethylene to the simultaneous action of oxygen and water, in the presence of a catalyst", etc.

The evident purpose and effect of the reissue was, as the Court below held, to make the voluntary addition of water which was mandatory in the original, optional in the reissue. This the law does not permit.

We submit, therefore, that the Court below correctly held that the original patent contemplated the voluntary introduction of water into the reaction chamber, not as an optional procedure, but as a step that would always be taken, that the reissue patent does *not* contemplate the voluntary introduction of water into the reaction chamber as a necessary procedure, and that claims 8 and 9 of the reissue patent contain no such requirement. In the light of these facts, and under the well-settled rules of this Court, the patent in suit is invalid as a matter of law.

Idealization of the Original Disclosure.

Pages 2 and 3 and the first sentence on page 4 of respondent's brief are directed to assertion of the great importance of a chemical process by which "the direct oxidation of ethylene with oxygen" is achieved. This is said to be an achievement the desirability of which has been recognized for years and the reissue patent in suit is referred to as "The patent . . . for the invention which made this 'impossible' thing a *fait accompli.*"

There is not, however, a word in the original Lefort patent about the direct oxidation of ethylene with oxygen, and no suggestion that that is the achievement which Lefort intended to patent. Indeed, these portions of respondent's brief are, it seems to us, a full exposé of that ambitious scheme of respondent's which was first manifested in the reissue patent itself—the scheme

to expand and idealize the subject matter patented, after the issuance of the original patent, so as to embrace subject matter which Lefort did not originally evidence any intention to monopolize, and which in the interim had been put into use by others. It is a perfect example, we submit, of that abuse of the reissue statute which it was the purpose of this Court, in *Miller* v. *Brass Company*, 104 U. S. 350, to put an end to. (See *Sontag, etc.* v. *National, etc.* May 20, 1940, 310 U. S. 281; pages 289 and 293.)

Intervening Rights.

The respondent, with reference to petitioner's point that substantial investment, amounting to over $100,000, in experimental work which ultimately resulted in a commercial operation should be protected by the doctrine of intervening rights, emphasizes that this is "a novel proposition of law".

It is, as we pointed out in our main brief, a question of first impression in this Court, and the argument of our brief is that effort and money expended in this degree by "innocent parties" to use the language of this Court in the *Sontag* case (310 U. S. 281 at pages 293-4) should be included within the shelter of the "sense of justice and policy" referred to in that case (page 295).

Respondent's counsel in their brief say (page 24) that "for obvious reasons, the doctrine necessarily is limited" to "*commercial operations.*" We do not think so.

We think the fact that petitioner undertook further expenditures in building its commercial plant after the reissue had been granted in reliance on the estoppel raised by its intervening labors has no relevance to this question. The actual cash expenditures of petitioner upon the work carried out prior to the application date of the reissue amounted to $132,000. (R. Vol. I, p. 226). We believe that in view of the substantial nature of these expenditures and the scope and extent of the work done prior to the application date of the reissue, intervening rights had already accrued to petitioner as of that date.

But even if the experimental nature of the work carried on by petitioner prior to the application date of the reissue should be discounted because of its character, this objection was removed by the further developments in the period preceding the date upon which the reissue patent was granted. Prior to that date the period of experimentation and development came to an end, the process was completed and application for patent on the perfected invention was filed (R. Vol. I, pp. 217, 224-5). Petitioner here appears not as an intervening *experimenter*, but as an *intervening inventor*.

The rights of an intervening inventor were expressly mentioned by this Court in the *Sontag* case (Petitioner's Brief, p. 51; 310 U. S. at pages 294 and 295), and apparently respondent does not question these rights, for on this branch of the case respondent's only objection is that the period of intervention is limited by the application date of the reissue; not its date of grant (Respondent's Brief, p. 25).

We believe that respondent's point is ill taken. Respondent asserts that it is an absolute rule that intervention subsequent to the date of application for a reissue will not be recognized by the courts. This statement is not justified. It is true that in the majority of cases that have been litigated the facts established intervention as occurring prior to the application for reissue and consequently the date of grant has received infrequent mention in the decided cases. However, in two of the leading cases on this subject, the date of grant of the reissue was treated as the critical date (*Autopiano Co.* v. *American Player Action Co.*, 222 Fed. 276, 282; *A. Liley et al.* v. *Samuel C. Tatum Co.*, 240 Fed. 979, 982), and in a recent decision of the Court of Appeals for the Second Circuit—the Court in which issues of patent law arise more frequently than in any other in the country—it was asserted (*Otis Elevator Company* v. *Atlantic Elevator Company*, 47 F. (2d) 545, 549):

"In the first place, the critical date should certainly be that of the re-issue itself, not of the application, since the application is not published."

We think that in reason and in principle this proposition is correct.

The public is not informed either actually or constructively of the filing of the application for a reissue. For all purposes the original patent stands as the sole declaration of the patent owner's rights until the actual grant of the reissue. Even after application for reissue has been filed, the original patent remains in force, and if the application is rejected, continues to determine the rights of the patent owner. Since applications for reissue are frequently rejected, even the applicant himself cannot know until the actual date of grant what additional rights he may secure. For the public, who are without knowledge of the applicant's efforts to enlarge his monopoly, the original patent remains the definitive statement of its owner's rights until the reissue patent has been published by the Patent Office.

Nor has the public any reason to believe that reissue will be sought, nor any duty to anticipate such action on the part of the patent owner. In this connection it is to be borne in mind that the right to reissue with broadened claims is a very special and exceptional one. (*Miller* v. *Brass Co.*, 104 U. S. 350 at pp. 354-5; *Mahn* v. *Harwood*, 112 U. S. 354 at p. 362; *Sontag* v. *National*, 310 U. S. 281 at pp. 289-290) There is no presumption that a patent can be so reissued (*Ashland Fire Brick Co.* v. *General Refractories Co.*, 27 F. (2d) 744, 746; C. C. A. 6). The presumption, on the contrary, is that what has not been claimed in the patent is public property (*Mahn* v. *Harwood*, 112 U. S. 354, 361, and *Parker & Whipple Co.* v. *Yale Clock Co.*, 123 U. S. 87, 102); and that if the patentee described and claimed only a part of his invention, the residue has been abandoned to the public (*McClain* v. *Ortmayer*, 141 U. S. 419, 423-4; *Deering* v. *Winona Harvester Works*, 155 U. S. 286, 296). The public has a right to rely on these presumptions and accept the limita-

tions of the patent as final until the inventor's exceptional right to reissue has been made complete by the grant of a reissue patent.

It is not suggested in this case that petitioner had notice of the application for reissue. Petitioner simply continued its efforts in innocence of respondent's change of position and in reliance upon the limitations of the original patent. Those efforts came to fruition before the reissue was granted and before notice of respondent's new claims reached petitioner. We submit that there can be no doubt that petitioner's intervening rights vested as of that date if not before.

Respectfully submitted,

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OCT 23 1941
CHARLES ELMORE CROPLEY
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IN THE

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October Term, 1941
No. 680

U. S. INDUSTRIAL CHEMICALS, INC.,
Petitioner,

versus

CARBIDE AND CARBON CHEMICALS CORPORATION,
Respondent.

BRIEF FOR RESPONDENT IN OPPOSITION TO PETITION FOR WRIT OF CERTIORARI

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VERSUS

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Respondent.

BRIEF FOR RESPONDENT IN OPPOSITION TO PETITION FOR WRIT OF CERTIORARI

This is an ordinary suit for patent infringement decided in favor of respondent by the District Court, and unanimously affirmed by the Court of Appeals for the Fourth Circuit. Concurrent rulings were adverse to petitioner on all defenses urged, and were based on concurrent findings of fact which it now seeks to have reviewed. An extensive petition for rehearing was presented and denied. There have been no other decisions on the patent. The case presents no special circumstances to justify review.

As this Court in *Keller* v. *Adams-Campbell Co.*, 264 U. S. 314, 319, said:

> "Such an ordinary patent case with the usual issues of invention, breadth of claims and non-infringement,

this Court will not bring here by certiorari unless it be necessary to reconcile decisions of Circuit Courts of Appeal on the same patent."

Further Statement of the Case

Petitioner's "Statement of the Case" requires both correction and amplification. References to the part of the record printed as Appendix to Plaintiff-Appellee's Brief will be (App. R.) and to the part printed as Supplement to Defendant-Appellant's Brief will be (Supp. R.).

The patented subject matter concerns a highly technical chemical process for making an old and well-known commercial product, ethylene oxide. The invention was radically new (App. R. 183). The patentee invented a method of directly combining the two gases ethylene and oxygen to yield ethylene oxide without accompanying formation of other oxygenated compounds, such as aldehydes. He discovered that ethylene oxide is thus produced by subjecting a mixture containing ethylene and molecular oxygen to an active surface silver catalyst and a 150°-400° C. temperature in a confined space, called the reaction zone, with water always present in such zone (App. R. 21). At these temperatures the water is, of course, in vapor form.

The invention was made in France by a citizen of that country. His original application for United States Letters Patent was drafted and prosecuted by a French attorney unfamiliar with chemistry. The original patent issued April 23, 1935. Petitioner and respondent were independently in communication with the French owner in the Spring of 1936. Respondent succeeded in acquiring the American rights in April 1936, and petitioner was notified of that fact by the French owner (App. R. 148).

Application for reissue of the patent was promptly filed in September 1936 in strict conformity with the statute. After a thorough consideration by the Patent Office (Supp.

R. 285-365) the reissue patent was granted in May 1937. Both the District Court and the Circuit Court of Appeals made findings of fact that the reissue patent was for the same invention as the original patent, and valid. On this issue, both courts made findings that the introduction of water (as distinguished from its presence)* in the reaction zone was not an essential or material step in the process disclosed by both the original and reissue patents.

Findings of Fact No. 7 and No. 8 of the District Court recite:

> "7. There is no variance between the invention described in the specifications and claims of the original patent and in the specifications and claims 8 and 9 of the reissued patent in suit.
>
> 8. With respect to water, the specifications of the original patent are not essentially different from those in the reissued patent. Professor Arthur B. Lamb, testifying on behalf of the plaintiff, has satisfied the Court, through his very clear exposition of the character and results of his laboratory tests, that one skilled in the art, following the teachings of the original patent, will be successful in producing what that patent calls for, and in obtaining such result whether the addition of water be considered as mandatory or as optional, and that he will obtain the same result if he follows the teachings of the reissued patent in suit. In other words, what Professor Lamb accomplished by following the original patent proves not only the adequacy of its disclosure as to how to carry out the process successfully, but, in addition, conclusively demonstrates that there is no variance between the

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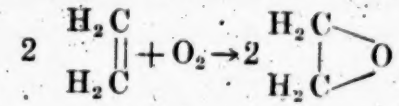
*Some water is always formed and present in the reaction zone, but, regardless of its source, water does not enter the ethylene oxide forming reaction.



Water is not a reactant in the process (App. R. 101).

> subject matter of the original and the reissued patent. This testimony is confirmed by the testimony of Professor Frazer, the inter-partes neutral witness*, and also by that of Professor Stevenson and Dr. Curme, witnesses for the plaintiff." (Supp. R. 24)

As to these the Circuit Court of Appeals said:

> "Is this difference vital, essential, substantial, material? Judge Coleman answered this question categorically in the negative, in his findings of fact number 7 and number 8." (App. R. 177)

and

> "* * * their testimony [of plaintiff's witnesses and the court-appointed neutral expert] set against, and read in the background of the entire record of the instant case, affords ample warrant for the findings by Judge Coleman." (App. R. 181-182)

Thus the courts below rested their rejection of the defense of different invention on concurrent findings of fact. Petitioner now merely readvances the same contentions and citations urged before the Courts below. Every one of the decisions of this Court cited on pages 5 and 6 of the petition was cited and discussed in Petitioner's Main Brief before the Circuit Court of Appeals and in its Petition for Rehearing. The fact that such court carefully considered petitioner's contentions before finding them untenable is apparent from the fact that many of those decisions are referred to in its opinion.

The present case is not one where the reissue was applied for in the light of, or to cover, any development subsequent to the application for the original patent. Petitioner's infringing operations were not begun until two years after the reissue patent was granted, nor until two years and seven months after the application for reissue had been filed (Supp. R. 228).

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* Appointed by the District Court.

What relatively slight work had been done by petitioner did not have even experimental fruition prior to the filing of the application for the reissue (Supp. R. 224). There is no proof of record by which petitioner's laboratory expense can be related to the infringement begun two and one-half years later (Supp. R. 197). The petitioner embarked upon its infringement with full knowledge and after notice of the reissue patent (Supp. R. 228). Both courts below found the foregoing facts, and consistently followed applicable decisions of this Court in rejecting the defense of intervening rights.

Questions Presented

Under this heading the petition postulates as fact, matters found not to be facts by both courts below. The first so-called question reads:

> "Can a patent for a process which includes a step asserted to be mandatory and described and claimed in the original patent as an essential feature of the invention be reissued to include a process which achieves the same result while dispensing with the step in question?" (Pet. p. 5)

On the contrary, as pointed out above, the introduction of water, as distinguished from its presence, in the reaction zone is **not** "an essential feature" in the invention at bar, and was **not** "described and claimed in the original patent as an essential feature". These facts were concurrently found below (App. R. 177-178).

The second so-called question reads:

> "Does one who in good faith and at great expense completely developed a process which does not infringe an original patent but does infringe the broadened claims of a reissue granted after the development work is complete but before the new process is put

> into commercial use, acquire intervening rights barring injunctive relief against continued use of the process!'' (Pet. p. 5)

To the contrary, it was concurrently found below that petitioner's conduct of the process to be enjoined was not a ''continued'' use but was a subsequently begun use (App. R. 186); that the filing date of the reissue application preceded any substantial expense and any consummation of petitioner's laboratory work (Supp. R. 204, 225); and that infringement was not innocent. Moreover, if by ''developed'' a ''new'' process, petitioner intends to imply that it discovered the possibility of omitting the introduction of water to the reaction zone, or that its process lacks such introduction, both implications are unwarranted. The concurring fact findings of both lower courts are that such introduction of water is immaterial to the process of both the original and reissue patents (*supra* pp. 3, 4), and petitioner's own description of the process practiced by it states that 1.5% of water is introduced to the reaction zone in addition to that formed therein (Supp. R. 279).

The sole question properly before this Court on the petition is,

> In the absence of (a) any conflict of decision on the patent, (b) any public interest affected by the suit, and (c) any conflict in principle of law between the decision below and the applicable decision of this Court, should writ of certiorari be granted merely to review concurrent findings of fact by the courts below?

Summary of Argument

I.

There is no conflict of decisions on the patent at bar, no question of law not heretofore settled by this Court, and no question decided below inconsistently with the decisions of this Court or of the Circuit Courts of Appeals.

II.

The decisions below denying petitioner's claim of intervening rights consistently follow the applicable decisions of this Court and of the Circuit Courts of Appeals.

III.

Petitioner's argument for review on the ground that there is remote likelihood of future litigation on the patent is conceded by petitioner to have no support in the record. It has no more basis than in any conventional patent suit instituted when the first infringement occurs, and is untenable.

Argument

I.

There is no conflict of decisions on the patent at bar no question of law not heretofore settled by this Court and no question decided below inconsistently with the decisions of this Court or of the Circuit Courts of Appeals.

Petitioner represents that the introduction of water as distinguished from its presence, in the reaction zone was an essential step in the process of the original patent and that the Circuit Court of Appeals below so found the fact. To the contrary, the lower courts concurred in the finding of fact that such introduction of water was non-essential, non-substantial, and immaterial in the process of the original patent.

The Court of Appeals stated that, while the original patent contemplated always introducing water, such introduction was not disclosed as essential in the process. It supported its finding by reference to the original patent disclosure, saying:

> "We think it is fair to state, in the light of the record in this case, that under the original patent, the essentially vital aspects of the process are (1) subjecting ethylene to the action of the oxygen of air; (2) in a reaction-chamber at controlled and specified temperature; (3) in the presence of a designated type of catalyst." (App. R. 178)

It reenforced this finding by further reference to the disclosure of the original patent as to the non-essential role of water in the chemistry of the process. Water is there stated to increase the efficiency of the process and to diminish undesirable by-products besides being a convenient diluent, and, as the Court remarked, "the original

patent does not mention quantity or proportion of water that was to be voluntarily introduced" (App. R. 178). Even petitioner's expert admitted that the amount is not material (App. R. 92).

The patent statutes require an applicant for a patent to state in his specification what he considers the best way of carrying out his invention, but the refinements thus indicated as preferred do not thereby become restrictive essentials. Neither court below found that the claims of the original patent included an expressed limitation to the voluntary introduction of water. The original claims called for "subjecting ethylene to the simultaneous action of oxygen and water" without specifying whether the water was introduced separately, or with the air, or was present by formation *in situ*. In petitioner's process, as conducted, some water is introduced with the air and a further quantity is present by formation *in situ* (Supp. R. 279-280). Claims 8 and 9 of the reissue patent likewise require the joint presence of ethylene, oxygen and water in the reaction zone, which all the expert witnesses agreed is the only place of interest (App. R. 95; Supp. R. 132).

Having found from consideration of the original patent that the voluntary introduction of water was non-essential, the Court of Appeals went on to consider the testimony of the witnesses skilled in the art as to what the original patent disclosed to them, and found its own conclusion confirmed since "the expert testimony here strongly favors the contentions of the plaintiff" (App. R. 180).

The concurrent finding that there is no essential, substantial or material difference between the reissue and the original patents was recognized as controlling the conclusion in favor of the validity of the patent under the applicable decisions of this Court, since the Circuit Court of Appeals stated:

> "The law is clear, under the reissue statute (Rev. St. §4916; U. S. C. A., Title 35, §64), that there can be no reissue patent for a new invention. Indeed, the

cases go much further than this to hold that the reissue patent is invalid if, between the inventions disclosed first in the original patent and then in the reissue patent, there be variances that are essential, substantial and material. A leading case is Parker & Whipple Co. v. Yale Clock Co., 123 U. S. 87. Other important cases are Seymour v. Osborne, 11 Wall. 516; Powder Co. v. Powder Works, 98 U. S. 126; Mahn v. Harwood, 112 U. S. 354. And the United States Supreme Court has cited and applied the Parker & Whipple Co. case, supra, in Matthews v. Ironclad Mfg. Co., 124 U. S. 347, 351; Yale Lock Co. v. James, 125 U. S. 447, 464; Corbin Cabinet Lock Co. v. Eagle Lock Co., 150 U. S. 38, 42-43. And see, decided by this Court, the cases of Marvel Buckle Co. v. Alva Mfg. Co., 196 F. 1006; A. D. Howe Machine Co. v. Cooffield Co., 197 F. 541. Yet a reissue patent is not invalid merely because the reissue patent contains claims broader than the original, Topliff v. Topliff, 145 U. S. 156, or claims narrower than the original, Miller v. Brass Co., 104 U. S. 350." (App. R. 174-175)

This Court has consistently held broadened reissue patents valid where the differences from their originals were non-essential, or unsubstantial, or immaterial; and has consistently held other broadened reissues invalid where the differences from their originals were essential, or substantial, or material.

In *Seymour* v. *Osborne*, 78 U. S. 516, 544, 545, this Court said:

"Power is unquestionably conferred upon the commissioner to allow the specification to be amended if the patent is inoperative or invalid, and in that event to issue the patent in proper form; and he may, doubtless, under that authority, allow the patentee to redescribe his invention and to include in the description and claims of the patent not only what was well described before but whatever else was suggested or substantially indicated in the specification or drawings which properly belonged to the invention as actually

made and perfected. • • • Letters patent reissued for an invention substantially different from that embodied in the original patent are void and of no effect, • • •."

In *Morey* v. *Lockwood*, 75 U. S. 230, 241, the reissue was held valid where,

"The change is one of form and not of substance • • •."

In *Moffit* v. *Rogers*, 106 U. S. 423, 427, 428, the reissue was held invalid because:

"It is, therefore, clear that it covers a contrivance essentially different from that described in the original specification and claim. • • •

The difference between the device covered by the specification and first claim of the original patent, and the device which might be embraced by the specification and first claim of the reissued patent, is essential and palpable. • • •

The specification and first claim of the reissued patent are a plain attempt to include a device which was not and could not be fairly covered by the original patent."

In *Marsh* v. *Seymour*, 97 U. S. 348, 356, it is said:

"but the patentee may redescribe his invention, and include in the description and claims of the specification not only what was well described before, but whatever else was suggested or substantially indicated in the old specification, drawings, or patent-office model, which properly belonged to the invention as actually made and perfected."

In *Powder Company* v. *Powder Works*, 98 U. S. 126, the reissue was held invalid because it was for a process of compounding nitro-glycerine with gunpowder instead of the originally claimed process of exploding nitro-glycerine. The Court said at page 137:

"The invention of the one did not involve the invention of the other. The two inventions might have been made by different persons, and at different times."

In *Collar Company* v. *Van Dusen*, 90 U. S. 530, 558, th Court held:

> "Whether a reissued patent is for the same inve tion as the surrendered original or for a different on must very largely be determined by a comparison the two instruments, as the decision must necessaril depend upon the question whether the specificatio and drawings of the reissued patent are not substa tially the same as those of the original; and if no whether the omissions or additions are or are n greater than the law allows to cure the defects of th original specification."

In *Smith* v. *Goodyear Dental Vulcanite Company*, 93 U. S 486, 499, 500, the reissue was held valid because:

> "Certainly it is not another process; and as its resu is the same, it is impossible to hold that the reissue patent is for a different invention from the one pr tected by the original patent."

In *Topliff* v. *Topliff*, 145 U. S. 156, 171, it is said:

> "To hold that a patent can never be reissued for a enlarged claim would be not only to override th obvious intent of the statute, but would operate i many cases with great hardship upon the patente The specification and claims of a patent, particularl if the invention be at all complicated, constitute on of the most difficult legal instruments to draw wit accuracy, and in view of the fact that valuable inve tions are often placed in the hands of inexperience persons to prepare such specifications and claims, it i no matter of surprise that the latter frequently fa to describe with requisite certainty the exact inve tion of the patentee, and err either in claiming tha which the patentee had not in fact invented, or i omitting some element which was a valuable or esse tial part of his actual invention."

In the *Topliff* case, the Court reviewed the cases which had been decided since the *Mahn* v. *Harwood* case (112 U. S. 354) and, as to those in which reissues had been held invalid, stated at page 169 that:

> "it will be found that the opinion of the court was put upon the ground, either that the patentee had been guilty of inexcusable laches, usually of from four to sixteen years, or that circumstances had occurred since the granting of the original patent which made the reissue operate harshly or unjustly to the defendant in the case."

Of the thirteen decisions of this Court cited on pages 5 and 6 of the petition, ten were rendered before the *Topliff* v. *Topliff* decision. As to the three rendered later:

Huber v. *Nelson*, 148 U. S. 270, involved a patent where the flushing tank, an element of the combination of all the original claims, was eliminated from the claims of the reissue for the purpose of covering intervening devices.

Corbin v. *Eagle Lock Co.*, 150 U. S. 38, involved a reissue for the combination of a lock and special mortise, whereas the original was for the lock *per se*.

Olin v. *Timken*, 155 U. S. 141 dealt with a broadened reissue not filed until six years after the original patent, and which thus violated the two-year rule laid down in the *Topliff* v. *Topliff* case.

The statement of petitioner (Pet. p. 21) that

> "This Court has not had occasion to pass on any case involving interpretation of the 'same invention' requirement of the reissue statute since *Olin* v. *Timken*, decided in 1894 (155 U. S. 141)."

is in error. The "same invention" requirement was considered and passed on in *Abercrombie & Fitch Co.* v. *Bald-*

win, 245 U. S. 198, where the reissue patent related to improvements in acetylene gas generating lamps and the broadened reissue patent held valid. The Court said at page 207:

> "There is nothing in this [the reissue] but what was clearly implied in the original, except the shape of the stirrer. In the original it is described and represented as bent. In the reissue it is stated to be obvious that the stirrer need not always be bent 'or extend radially from the mouth of the tube.'
>
> We are unable to assign to this the extent of alteration that counsel do * * *. One or the other might be better, according to the extent of the dispersion required, and one naturally suggested the other."

This Court also passed on the requirement of same invention in *Vandenburgh* v. *Truscon Company*, 261 U. S. 6, where the patentee had never used the invention of the original patent and secured the reissue nine years later for the purpose of covering intervening devices.

Thus nothing remains of petitioner's argument except a contention that the courts below erred in considering expert testimony as to what the original and reissue disclosed to them. Here also petitioner's contention is plainly untenable and in conflict with the decisions of this Court.

In all patent cases the question of the disclosure is addressed to the "person skilled in the art or science to which it appertains, or with which it is most nearly connected". (R. S. 4888)

In the case of a patent in the highly technical field of catalytic chemistry it is doubly proper that the question be, "What does the patent disclose to the chemist?". There are invariably verbal differences between original and reissue patents. The question of whether the *invention* remains the same is not one of whether there is a difference in form but whether there is a difference in substance.

On account of the very nature of the patent subject matter—a chemical process involving catalysis—the court

reviewed the testimony of the chemist witnesses of both parties and of a neutral expert appointed by the court on the question of what the two patents disclosed to them as persons skilled in the art. This consideration of the expert testimony was inherently necessary and proper, and the propriety of such consideration has been well stated by this Court in the following cases, among others:

> "Cases doubtless arise where the language of the specification and claim, both of the surrendered and reissued patents, is so interspersed with technical terms and terms of art that the testimony of scientific witnesses is indispensable to a correct understanding of its meaning." *Seymour* v. *Osborne*, 78 U. S. 516, 546.
>
> "It is not the construction of the instrument, but the character of the thing invented, which is sought in questions of identity and diversity of inventions." *Bischoff* v. *Wethered*, 76 U. S. 812, 816.

The rule is also recognized in the textbooks:

> "The seventeenth defense always requires to be supported by the introduction of the original patent [Seymour v. Osborne, 11 Wall. (78 U. S.) 516, 546, 20 L. Ed. 33 (1871)], and generally requires expert testimony showing that the outward embodiment of something claimed in the reissue, is substantially different from anything described in the original patent and apparently intended to be claimed therein." *Walker on Patents* (Deller's Ed.) Vol. Three, p. 2040.

There is some implication by petitioner that claims 1 to 7 of the original patent (also appearing in the reissue patent) were not infringed because limited to the introduction of water. The implication is unwarranted because (a) there was no finding by either court below that such claims were so limited and (b) petitioner, in its practice of the process, introduces 1.5% by volume of water with the ethylene and oxygen to the reaction zone.

Petitioner objects to the characterization of its defenses by the Circuit Court of Appeals as containing

> "little or no appeal to the beneficent principles of equity and good conscience",

and petitioner points out that this Court has shown a determination to guard against

> "* * * any abuse of that privilege by which the monopoly originally contemplated is artifically enlarged to embrace subsequent developments, thereby subjecting industry to hidden liens and unknown liability to vexatious lawsuits. * * *" (Pet. p. 19)

The implication that the case at bar is one where the reissue patent was so motivated or effective is utterly without record support and violates the findings below.

The present reissue was applied for promptly on the basis of nothing more than a study of the original patent by respondent after its rights were acquired (Supp. R. 267, 275); and the application was filed without respondent's knowledge of any activities by petitioner and at a time when petitioner's activities were secret and experimental (Supp. R. 219). Indeed, petitioner's infringement did not begin until more than two and one-half years after the application for reissue was filed and until more than two years after the reissue was granted.

In the light of both decisions below it is sheer pretense for petitioner to suggest that the reissue at bar was enlarged to embrace "subsequent discoveries, improvements or developments" by petitioner or by respondent or by anyone else.

Likewise for petitioner to say that "two processes" are involved is contrary to the findings of the District Court which were concurred in by the Circuit Court of Appeals. It was aptly held by the latter:

> "And, if claims #8 and #9 of the reissue patent had been added to the claims of the original patent, we

do not believe these claims could have been held to be invalid on the ground that these claims were not sufficiently covered by the specifications of the original patent." (App. R. 183)

The nub of the present petition is whether this Court shall institute the practice of reviewing on certiorari conventional patent cases where there are no conflicting decisions on the patents in different circuits and where the controlling findings of fact are concurrent in the courts below.

As this Court stated in *Layne & Bowler Corporation* v. *Western Well Works, Inc., et al.*, 261 U. S. 387, 393:

"* * * it is very important that we be consistent in not granting the writ of certiorari except in cases involving principles the settlement of which is of importance to the public as distinguished from that of the parties, and in cases where there is a real and embarrassing conflict of opinion and authority between the circuit courts of appeal. The present case certainly comes under neither head."

The decisions of District Courts and of Circuit Courts of Appeals for other circuits cited by petitioner (Pet. p. 21, 22), exhibit no conflict in principle with the decision below in the case at bar. In none of the cases cited by petitioner was a reissue patent invalidated or denied after a finding that the variance from its original was in a non-essential, unsubstantial, and immaterial respect.

Thus, in *Featherstone* v. *George R. Bidwell Cycle Co.*, 57 Fed. 631, 635-6, the difference concerned "a substantive part of his improvements" and "the claim which he asked for and obtained [by the original patent] embodied the parts which the description treated as substantive and valuable and only those parts", and the Court further stated:

"If, in the description of the invention, the patentee had indicated that he regarded the protective strips

merely as a desirable or preferential feature of his devices, it is not open to doubt that it would have been the appropriate office of a reissue to correct the claim of the original patent by eliminating them from it."

The others similarly present no conflict in principle, for example:

"Thus it will be seen the original patent and each of its claims call for anti-friction rollers nested or alternated, combined with a resilient centering device. These two things are vital elements of that patent. Now, it is sought by reissue to drop out the distinctive feature of the patent as described in the claims, and substitute another element, * * *" *Chicago Ry. Equipment Co.* v. *Perry Side Bearing Co.*, 170 Fed. 968, 974.

"The sole question in the case is whether or not there is sufficient disclosure in the original application to warrant granting appellant the claims at bar. * * * Appellant's reissue application contemplates that the failure of combustion will so operate the control apparatus while the pilot light is still in operation as to shut off the fuel. The original disclosure did not teach or suggest this result or manner of operation." *In re Williams*, 75 F. (2d) 520, 521.

"The claims that went to [original] patent are limited to rigid material * * * They [the reissue claims] do not contain any reference to the features of rigidity or shape retaining which are stressed in the [original] patent." *In re Overbury*, 95 F. (2d) 331, 332.

The findings of fact by the courts below in the case at bar were based on a comparison of the two patents and on testimony as to the process disclosed thereby to persons skilled in the art. Under the consistent decisions of this Court and of the Circuit Courts of Appeals, these findings support the conclusion on validity likewise reached concurrently below and call for denial of the petition.

II.

The decisions below denying petitioner's claim of intervening rights consistently follow the applicable decisions of this Court and of the Circuit Courts of Appeals.

Petitioner was aware of the issuance of the original patent. It was in communication with the French owners of that patent as shown by an interchange of communications (Plaintiff's Exh. 22, App. R. 124-148), which we believe clearly exhibit negotiations toward purchase which were frustrated by respondent's purchase. While petitioner speaks of a total expenditure of $150,000.00 on "development work" prior to the date of issuance of the reissue patent, the fact is that the evidence fails to show how this was spent and how much of it was related to the infringing process which it began two years later to employ, as distinguished from non-infringing processes in commercial use and open to all (Supp. R. 197). The fundamental inequity of petitioner's claims to intervening rights was properly characterized in the opinion of the District Court, which said as to petitioner's investment in its infringing plant:

> "But this was done by the company's officials with their eyes open to possible results. If they were too hasty or ill-advised with respect to possible conflict between their rights or interests and those of the plaintiff, this is not something that a court of equity can relieve against. Indeed, it is precisely the sort of thing which a court of equity should condemn, not condone." (Supp. R. 20)

This was reiterated by the Circuit Court of Appeals:

> "Defendant's last defense is in the nature of an attempt to invoke against plaintiff an equitable estoppel, based largely on expenditures by defendant before the

issuance of the reissue patent. Defendant is here clutching for a very feeble straw. * * *"

"The erection of defendant's elaborate plant in Baltimore after the issuance of the reissue patent, and defendant's elaborate activities thereafter were all in the nature of a gamble on the invalidity of the reissue patent by the defendant's officers, who hoped, if they were thus fortunate, to prosper by the appropriation of the intellectual property of another. If, through over-hasty action, this chance broke against defendant, we see little need for the shedding of any crocodile tears over the misfortune thus brought on the defendant." (App. R., 185-186)

The decisions below are not in conflict with the decision of this Court in *Sontag Stores Co. v. Nut Co.*, 310 U. S. 281, or the decision of the Second Circuit Court of Appeals in *Otis Elevator Co.* v. *Atlantic Elevator Co.*, 47 F. (2d) 545, cited by petitioner.

In the *Sontag* case, prior to the application for the reissue petitioner openly practiced the very operations which were later sought to be enjoined and "Respondent was moved to obtain the reissue by petitioner's use of the accused machine" (p. 282).

In the *Otis Elevator* case, the reissue application was filed seven and a half years after the original patent issued. Before the reissue was applied for, there had been made two experimental installations and, in addition, a regular commercial installation "of an equipment in a Federal Reserve Bank in Cleveland, which was accepted and has since then been in continuous operation" (p. 546). Petitioner further notes that the Second Circuit Court of Appeals indicated in the *Otis* case that the granting date of the reissue, instead of the filing date of its application, might be considered the terminal date for an accrual of intervening rights. This was *obiter dictum* because the patent was held invalid and not infringed.

The settled rule is, as stated in Walker on Patents, Deller's Edition, Vol Two, p. 1384, and cases cited:

> "The period during which intervening rights may attach runs from the date of original issue to the date of application for the reissue. [Odell v. Stout, 22 Fed. 159, 163; Ashland v. General, 27 F. (2d) 744; Naivette v. Bishinger, 61 F. (2d) 433; Topliff v. Topliff, 145 U. S. 156, 169; Roos v. McMillan, 64 F. (2d) 568, 569.]"

Moreover the acceptance of the filing date of the reissue application works no unreasonable hardship on the public. The risk with respect to reissues is no more than, indeed is less than, the risk incurred with respect to all applications for original patents. The fact of filing an original patent application is maintained in secrecy in the Patent Office, and all industry inevitably runs the risk of losing research and development expense, however great, which precedes commercial operations found later to infringe patents subsequently granted on prior filed patent applications. On the other hand the fact of filing a reissue application is made public through endorsement on the filewrapper of its original patent, when application for reissue is made (Rules of Practice of United States Patent Office, Rule 91).

Of course, the distinction between dates is immaterial in the case at bar because *both* filing and granting dates long preceded the commencement of petitioner's infringement.

Finally the case at bar does not at all present the special question regarding intervening rights to which this Court referred in *Keller et al.* v. *Adams-Campbell Company, Inc.*, 264 U. S. 314, 318. There

> "the defendants had made the shields in question and built the machinery for future manufacture before the patentee applied for reissue * * *."

Here, petitioner's experiments amounted to relatively little before the reissue was applied for (Supp. R. 20), and it did not start to build its plant for future infringement until a year after the reissue was granted (Supp. R. 230).

III.

Petitioner's argument for review on the ground that there is remote likelihood of future litigation on the patent is conceded by petitioner to have no support in the record. It has no more basis than in any conventional patent suit instituted when the first infringement occurs, and is untenable.

There is no evidence of record showing improbability of further litigation on the patent in suit in other Circuits, and no occasion for the Court to review this case any more than all patent cases.

Petitioner attaches *ex parte* affidavits of one of its officers, Mr. Metzger, and of Mr. Lehman an officer of an alcohol company which is a stranger to the suit. These affidavits are *ex parte* and misleading. Mr. Metzger attended the trial (Transcript, p. 644) but was not called as a witness. Mr. Lehman had representatives at the trial who likewise remained mute. Both affiants still remain silent on such pertinent facts as how much of the alleged total cost would be in appurtenances not necessary to create the basis for a suit, and how much would be for equipment, including silver, having recoverable value for non-infringing use (Supp. R. 230). The financial risk necessary to conduct infringement on a sufficient scale to challenge the patent at bar would be insignificant in all cases when expressed in percent of assets of potential infringers. As to the patent at bar, the cost of committing infringement would be relatively no different from that in every conventional situation where the patented invention is radically new and industrially valuable.

Moreover, the cases cited by petitioner in support of its argument for exception from the rule are clearly distinguishable from the case at bar.

In *Schriber-Schroth Co.* v. *Cleveland Trust Co.*, 305 U. S. 47, the patent in suit had been found invalid by a Special Master and by the District Court and valid by the Court of Appeals for the Sixth Circuit. These contrary conclusions showed validity doubtful, and writ of certiorari was granted on a showing that "notwithstanding the doubtful validity of the patents, litigation elsewhere with a resulting conflict of decision was improbable because of the concentration of the automobile industry in the Sixth Circuit". (p. 50)

In *Paramount Corp.* v. *Tri-Ergon Corp.*, 294 U. S. 464, the patent had been held invalid by the District Court and valid by the Circuit Court of Appeals for the Second Circuit.

In *Altoona Theatres* v. *Tri-Ergon Corp.*, 294 U. S. 477, this Court pointed out that the case presented no question of concurrent findings by courts below on the issue involved.

In *Mackay Co.* v. *Radio Corp.*, 306 U.S. 86, the District Court held the patent invalid and the Court of Appeals for the Second Circuit had reversed. This Court stated at page 89:

> "We granted certiorari because of the nature and importance of the case, on a petition which urged as grounds for its allowance that validity and infringement of the Carter patent were in doubt and that, as petitioner is the only competitor of respondent in the business of world wide radio communication further litigation, resulting in conflict of decision among circuits, was improbable."

In the case at bar the findings of the District Court and of the Circuit Court of Appeals for the Fourth Circuit are concurrent, and it thus calls for

> "* * * the application of the well settled rule that the concurrent findings of the lower courts on questions of fact will be accepted by this Court unless clear error

is shown. Wright-Blodgett Co. v. United States, 236 U. S. 397, 402; United States v. State Investment Co., 264 U. S. 206, and cases there cited." *Thomson Co.* v. *Ford Motor Co.*, 265 U. S. 445, 447.

The Record in the case at bar, as well as the *ex parte* affidavits accompanying the petition, make no showing of any exceptional circumstance such as any concentration of chemical industries in the Fourth Circuit. On the contrary, the Record shows a potential threat of infringement in the Ninth Circuit, one of the *ex parte* affidavits attached to the petition suggests a hostile interest in the Third Circuit, and other competitive chemical companies able to infringe are located in various other Circuits.

Petitioner, with full notice of the reissue patent, was not deterred from risking its investment to commence infringement on a grand scale. If other competitors prove to be more reluctant to incur such risk their course might be reasonably ascribed to a well founded recognition of the validity of the patent.

Conclusion

The concurrent findings of fact of the District Court and the Circuit Court of Appeals for the Fourth Circuit establish that in full compliance with the Statute and in harmony with the decisions of this Court and of the Circuit Courts of Appeals in applying the statute, the reissue patent at bar is for the same invention as the original patent. No intervening rights accrued to petitioner, and the concurrent findings of the District Court and the Circuit Court of Appeals to this effect are likewise in harmony with the applicable decisions of this Court and of the Circuit Courts of Appeals. There is no geographical concentration of potential infringers in any circuit, nor other exceptional circumstance calling for issuance of the writ.

As stated by the Circuit Court of Appeals herein:

> "This seems to be a typical case of a valid, original basic patent, in which the claims were inadvertently drawn in terms that were too narrow and these claims were, accordingly, subject to valid correction under a reissue patent." (App. R. 184)

The petition should be denied.

Respectfully submitted,

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Dated: New York, N. Y., October 22, 1941.

Revised Statute.

"Sec. 4888. (U. S. C., title 35, sec. 33.) Before any inventor or discoverer shall receive a patent for his invention or discovery, he shall make application therefor in writing, to the Commissioner of Patents, and shall file in the Patent Office a written description of the same, and of the manner and process of making, constructing, compounding, and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct, compound, and use the same; and in case of a machine, he shall explain the principle thereof, and the best mode in which he has contemplated applying that principle, so as to distinguish it from other inventions; and he shall particularly point out and distinctly claim the part, improvement, or combination which he claims as his invention or discovery. The specification and claim shall be signed by the inventor. No plant patent shall be declared invalid on the ground of noncompliance with this section if the description is made as complete as is reasonably possible."

Rules of Practice, U. S. Patent Office.

"91. The application for a reissue must be accompanied by an offer to surrender the original patent. The application should also be accompanied by the original patent, or, if the original is lost or inaccessible, by an affidavit to that effect. The application may be accepted for examination in the absence of the original patent or the affidavit, but one or the other must be supplied before the case is allowed. If a reissue be refused, the original patent will be returned to applicant upon his request.

When an application for a reissue is filed, the examiner will place in the files of the original patent a notice stating that an application for reissue has been filed and the date it was filed. When the reissue is granted or the reissue application is otherwise terminated, that fact will be added to the notice in the file of the original patent."

IN THE

Supreme Court of the United States

October Term, 1941

No. 680

U. S. INDUSTRIAL CHEMICALS, INC.,
Petitioner,

vs.

CARBIDE AND CARBON CHEMICALS CORPORATION,
Respondent.

BRIEF FOR RESPONDENT.

SAMUEL E. DARBY, JR.,
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CLAIR V. JOHNSON,
CLAIR W. FAIRBANK,
Of Counsel.

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BRIEF FOR RESPONDENT.

Opinions Below.

The opinion of the Circuit Court of Appeals (R. II, pp. 173-187) is reported in 121 F. (2d) 665. The opinion of the District Court (R. I, pp. 3-22) is reported in 34 F. Supp. 813.

The Questions Presented.

For reasons which later will be made clear, respondent does not agree that either of the two alleged "questions presented" appearing on page 2 of Petitioner's Brief is framed by the facts of this case. Because of this disagreement it is necessary for respondent to add so materially to petitioner's statement of the case as to warrant a complete restatement thereof.

Statement of the Case.

Ethylene Oxide.

Ethylene is a hydrocarbon gas, the existence of which has been known for more than a century. It has the chemical formula C_2H_4, from which it will be seen that it is composed of two atoms of carbon and four atoms of hydrogen.

Beginning as early as 1862, and extending throughout the years continuously until the invention of the patent in suit, the scientists and chemists throughout the world believed, and publicly asserted, that it was impossible to form ethylene oxide (having the formula C_2H_4O) by the *direct* oxidation of ethylene with oxygen—*it was regarded as a chemical impossibility.* One reason for this was because whenever ethylene was *directly* reacted with oxygen, other and less desirable oxygenated compounds (notably aldehydes) were immediately formed, to the exclusion of ethylene oxide. In consequence, in the past, whenever ethylene oxide *was* produced, it was produced *indirectly, i. e.* solely and exclusively by a series of chemical processes and reactions, all of which were signally characterized by the *absence* of direct oxidation of ethylene with oxygen.

Thus, as early as 1862, it was asserted by M. Ad. Wurtz, in his published work "Wurtz on Oxide of Ethylene, etc." (R. I, p. 454):

> "This oxide [oxide of ethylene] cannot be formed directly by the action of oxygen on ethylene, but it is obtained as a derivative of glycol, of which it is the anhydride or ether."

This continued to be the belief of the scientists and chemists until the Lefort invention here involved. Dr.

Arthur B. Lamb of Harvard University,[1] perhaps the leading chemist in the world today, testified in this case, in response to a question by the Court (R. I, p. 256):

> "* * * when I first saw this patent [the original Lefort patent] I was more or less dumbfounded, to tell you the truth, to think that you could realize this reaction, which, to a chemist, is quite a surprising reaction, and I did not know that it had been achieved."[2]

Throughout the years, however, the desirability—indeed, the great economic and industrial value—of direct oxidation of ethylene to produce ethylene oxide had been recognized; and countless efforts had been made to accomplish it. Even petitioner's Chairman, Mr. Adams, testified that "toward the end of 1933" he was advised by his own Research Department "that for 12 or 15 years people had been working toward the direct oxidation of ethylene" (R. I, pp. 221-222), without success. Thus, up to the time of the Lefort invention, the total of experience and scientific and chemical knowledge was summed up in the simple statement that the *direct* oxidation of ethylene to ethylene oxide was impossible of accomplishment.

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[1] Dr. Lamb is Professor of Chemistry at Harvard University. He had charge of Chemical Research for the Government during the first World War; he organized and directed the Fixed Nitrogen Research Laboratory in Washington, established by President Wilson for the purpose of converting the Government plant at Muscle Shoals into effective plants for the manufacture of fixed nitrogen from the air (R. I, p. 238).

[2] To the same effect is the testimony of Dr. Reston Stevenson, Professor of Chemistry of the College of the City of New York (R. II, pp. 8-9); Dr. J. C. W. Frazer, the noted chemical authority of Johns Hopkins University, appointed by the District Court as an impartial expert in the case (R. II, p. 84); and Dr. Hugh S. Taylor, Professor of Chemistry of Princeton University (R. II, p. 6). Additionally, Dr. Lloyd H. Reyerson, Professor of Chemistry at the University of Minnesota, in 1928 published an article to the same effect (R. I, p. 447).

The patent in suit is for the invention which made this "impossible" thing a *fait accompli*.

The acquisition of the patent by respondent.

Realizing the great utility of this invention, respondent purchased the United States patent in April, 1936, and proceeded immediately to prepare for commercial operations thereunder, with the result that by June 6, 1940, when the trial of this case was started, respondent was operating the process in its plant at South Charleston, West Virginia, to produce more than ten million pounds of ethylene oxide a year, and had already once doubled its facilities (R. II, p. 61; I, p. 20).

Indeed, the invention was of such great economic and industrial utility and value that petitioner, *more than a year after the grant of the reissue patent on May 18, 1937*, and with full knowledge and in conceded deliberate infringement thereof, invested more than a million dollars in the construction of its plant in Maryland to practice the invention of the patent in a defiant appropriation which it here seeks to justify (Petitioner's Brief, footnote p. 52). Moreover, petitioner launched upon its deliberate infringement despite the fact that the non-infringing and patent-free process of *indirectly* producing ethylene oxide was in commercial use and available to it (R. I, p. 229). Indeed, the unpatented *indirect* process is still being used by others.

Subject matter of the patent.

Lefort discovered that *if ethylene gas is exposed to molecular oxygen in the presence of water and a catalyzer, in a reaction chamber maintained within a specific range of temperature, ethylene oxide is produced.*[3] Moreover, by

[3] Molecular oxygen, represented by the chemical symbol O_2, is the form in which oxygen occurs in air.

this method ethylene oxide can be produced in commercial quantities and at sufficiently low cost to make its production in this manner an attractive commercial enterprise. This discovery also made available the ethylene oxide thus produced at low cost, for all of the many uses to which it theretofore had been put and to which it may be put in the future. Truly, therefore, this was undeniably and undeniedly a substantial contribution to the benefit of mankind.

As a matter of undisputed fact, the direct oxidation of ethylene to form ethylene oxide in accordance with the patented invention here involved, and as practiced by both petitioner and respondent, essentially requires a reaction zone or chamber maintained within specified temperature limits and in which are simultaneously present

(1) ethylene

(2) oxygen

(3) water

(4) a silver catalyst.[4]

With an understanding of what the invention is, we now turn to the original patent to see how it was therein described and claimed.

---

[4] As a matter of scientific fact, of these four materials only the ethylene and oxygen are *reactants*, and all of the ethylene oxide product is produced therefrom. The factors of water, catalyst and specified temperature are *causing influences* only. Petitioner in its Brief (for example, pp. 6, 17, 25), has elected to adopt a course of argument which rests on the assertion that water is also "one of the *reacting* ingredients" (p. 17), but the witnesses (including petitioner's own expert, Dr. Reyerson) agreed that water is *not* a reacting ingredient in the process (R. II, pp. 102-103, Id. p. 3). We here point out that this error of scientific fact, which forms petitioner's premise, is *essential* to the argument petitioner advances. However, we will not refer to it again because we propose to show the fallacies and utter want of merit in petitioner's argument regardless of this error. (Italics here and throughout this brief ours.)

The Original Lefort Patent (R. I, p. 283).

The specification of the original patent starts with the statement:

> "This invention has for object a process for the production of ethylene oxide which mainly consists in *subjecting ethylene to the simultaneous action of the oxygen of air and of water, in the presence of a catalyzer*, and, if need be, of hydrogen."

Note that it is the action of "oxygen *of* air and of water" that is required, not of oxygen *or* air *and* water.

It is a matter of common knowledge, and a fact conceded in this case (R. II, p. 122), that ordinary air includes both oxygen and water in its make-up. It is also a fact, conceded in this case (Petitioner's Brief, p. 18; see also R. II, p. 81), that the water in air is sufficient to cause the reaction to occur, under the stated conditions, which reaction will continue and produce the desired ethylene oxide product as long as the air and the ethylene are fed into the reaction chamber (R. II, p. 83).

Therefore, the opening statement of the original patent specification is significant in that with great particularity it points out, in complete harmony with the recited necessities for the direct oxidation of ethylene (*ante*, p. 5), that the ultimate product (ethylene oxide) is obtained by the simultaneous action on ethylene of the "oxygen *of* air *and* of water" in the presence of a catalyzer. Another way of saying the same thing would be that the product is obtained by the action of *air* on ethylene in the presence of a catalyzer, in view of the fact that *air* contains the necessary oxygen *and* water.

This is further emphasized by the statement of the patent (column 2, line 12):

> "The oxygen can be *the oxygen of the air, this latter gas being introduced in the reaction.*"

The specification then continues (column 2, line 14):

> "The *efficiency* of the reaction is *increased* by diminishing the CO_2 which is formed, *by introduction*, in this reaction, *of a suitable quantity of water.*"

From this language it will be noted that the introduction of air (with its water content) and ethylene into the reaction chamber, under the conditions specified, *causes* the desired reaction, and that it is merely its *efficiency* that is *increased* by the

> "introduction, in this reaction, of a suitable quantity of water".

In other words, it is not the *reaction* (the oxidation of ethylene) which is *effected* by the introduction of *this* particular water. To the contrary, it is merely the "*efficiency* of the reaction"—*already occurring*—that is *increased* by the introduction of *this* particular water.

The specification again states with respect to *this* particular, or *additional* water (column 2, line 35):

> "From experiments effected by the applicant, it results that, *if* water is introduced in suitable quantity, the reaction is not only *facilitated*, as above stated, but, in addition, the reaction giving CO_2 [an undesirable by-product] probably by direct oxidation of ethylene according to the equation:
>
> $$C_2H_4 + 3O_2 = 2H_2O + 2CO_2$$
>
> is checked, owing, as is probable, to the partial pressure of water."

From this again it will be seen that the statement is that "*if* water is introduced"—obviously meaning, as above shown, water *in addition* to the water (and oxygen) in *air*

necessary to *cause* the reaction—the reaction is "facilitated" and the formation of undesirable by-products is checked. Again it should be noted that this *additional* water, *if* introduced, is not recited as *causing* the reaction, but merely as *facilitating* it.

Three *modi operandi* are set forth in the specification (p. 2, column 1, lines 5-57), in *each* of which the common factor exists that ethylene and *air* are brought into contact in the reaction chamber in the presence of the specified catalyst, and at the specified temperature. This, alone, insures the production of ethylene oxide. In addition, *each* instance recites the presence of *additional* water, which, as has been shown, *may* be used to increase the "efficiency" of the reaction, or so that the reaction may be "facilitated" and the formation of undesirable by-products be checked.

The original specification likewise enumerates a large number of catalysts that might be used (p. 1, line 26). We are here concerned with but one of them, namely, silver alone, specified as number "(2)". No issue is raised in this Court as to the catalyst (Petitioner's Brief, p. 6).

Finally, the seven claims of the original patent warrant consideration. Claims 1, 2, 3, 6, and 7 are expressly limited to catalyzers composed of something *other* than silver alone, notwithstanding the fact that silver alone was specifically named as a catalyst in the specification. The remaining claims (4 and 5), though specifying silver alone as a usable catalyst, are expressly limited to the introduction of hydrogen into the reaction chamber, notwithstanding the fact that the specification specifically recites that the use of hydrogen is entirely optional.[5]

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[5] Additionally, various of the claims contain other wholly unnecessary limitations, such as the pressure at which the reaction is carried on and the use of carbon dioxide, both of which, likewise, are specifically recited by the specification as being entirely optional. This is admitted by Petitioner's Brief, top of p. 6, and second full paragraph on p. 9.

From the foregoing it will be seen that although the original patent disclosed *everything* that was necessary to produce ethylene oxide by direct oxidation, *and specifically recited every essential factor of the process, and the conditions under which it should be carried out*, the *claims* of the patent that were procured for this remarkable invention were mistakenly limited as to the *catalyst* or as to other *optional* details, which the patent on its face made evident, were wholly unnecessary and unintended limitations.

The reason for the reissue.

Factually, the original patent was prepared by a French attorney who "had no special academic or practical training in chemistry" (R. I, p. 358); and, quite obviously, he was unfamiliar with American patent practice. After respondent satisfied itself as to the feasibility of operating under the patent, and had purchased it from the French owner, steps immediately were taken in strict accordance with the Reissue Statute to remedy the "inadvertence, accident or mistake" by which this great invention had been inappropriately or inadequately claimed.[6] The propriety of such action, under such circumstances, has been expressly recognized by this Court in a great many cases, of which but one need be cited (*Topliff* v. *Topliff*, 145 U. S. 156); and is expressly conceded by petitioner (Petitioner's Brief, p. 26). Consequently, an application for reissue was filed on September 25, 1936—less than two years after the issuance of the original patent—and the reissue application was promptly prosecuted so that the reissue patent was granted a few months thereafter, on May 18, 1937.[7]

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[6] Section 4916 R. S., reproduced at the end of Petitioner's Brief.

[7] The testimony explaining how and why the reissue was applied for will be found at R. I, pp. 267-268, 275-276.

The reissue patent (R. I, p. 277).

Though the reissue specification was shortened and simplified, everything appears therein that it is agreed is essential to the direct oxidation of ethylene (see, *ante*, p. 5). The opening statement of the specification is:

> "This invention provides a specific and novel process for making ethylene oxide. It essentially consists in *causing* ethylene to combine directly with molecular oxygen at temperatures of about 150° to about 400° C. in the presence of a surface catalyst which favors the oxidation of ethylene to ethylene oxide under these conditions."

It should be noted that the foregoing statement defines the invention as "causing" the direct combination of oxygen and ethylene under the temperature and catalytic conditions specified.[8] This is precisely what the original patent stated in different words. Concededly (see *ante*, p. 5), a factor *essential* to *cause* oxygen and ethylene to combine, is *the presence of water*. This fact is specifically brought out later in the specification, and is expressly included in the claims, as we shall later show.

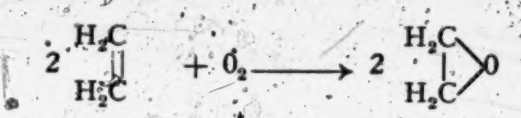
The specification continues (p. 1, column 1):

> "This process is characterized by an entirely unique reaction in which the direct addition of a single oxygen atom to the ethylene molecule occurs without the formation of significant amounts of other oxygenated compounds such as aldehydes."

Here, again, is a restatement of precisely what was disclosed in the original patent, referring to the theretofore

---

[8] The patentee stated this in identical *chemical* language in both his original and reissue patents (R. I. p. 283, column 1, lines 10 *et seq.*; p. 277, column 1, lines 17 *et seq.*) by means of the chemist's equation—



acknowledged impossibility of "direct" combination of oxygen and ethylene, and contracting, into the single assertion, the statement of the original patent concerning the avoidance of undesirable oxygenation by-products in the process.

Again, like the original patent, the reissue states (column 1, line 30):

> "*The oxygen can be the oxygen of the air,* and can conveniently be mixed with the ethylene prior to the reaction."

With the utilization of *air* as the source of oxygen for the reaction, there automatically is provided water, constituting moisture of the air, so that here again, as in the original patent, are present the gases necessary for the direct oxidation of ethylene—*viz.* ethylene, oxygen and water.[9]

The specification continues (column 1, line 33):

> "The oxidation of ethylene takes place with a giving off of heat, and it is, of course, desirable to maintain the temperature of the zone of reaction within the range specified. This can be *facilitated* by suitable dilution of the reaction gases, such as that accomplished by *the use of air as the source of oxygen,* and *some* water or carbon dioxide *in addition* to that formed *can* be admitted to the mixture in the reaction zone *if desired.*"

Here, again, as in the original patent, water *in addition* to the air-borne and formed water, "*can*" be admitted to the mixture in the reaction zone, "*if desired*", for the expressed purpose—identical with that of the original patent—that the reaction may be "*facilitated*".

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[9] Water is always in a vapor or gaseous form in air and in the reaction chamber at the temperature specified for the process.

The specification then proceeds to describe the process (column 1, line 44) as:

> "• • • passing a mixture *containing air* and ethylene through a tube • • • within which is placed such a surface catalyst as one composed of silver • • •"

Then follows the description and explanation of the last factor necessary to the complete process, namely, the temperature range, the details of which are not here in dispute, and which concededly are the same in both patents.

Finally, the specification of the reissue states (column 2, line 12):

> "*In any case*, the ethylene and oxygen are thus reacted simultaneously at the temperatures set forth *in the presence of a surface catalyst and of water*, and the process is conducted to produce ethylene oxide *as a direct product* in substantial and economic amount."

By this language the patent states, as clearly as language permits—and as did the original patent—that the *necessities* of the patented process for the direct oxidation of ethylene to produce ethylene oxide, consist of directly combining ethylene and oxygen *in the presence of water* and a catalyst, under specified temperature conditions in the reaction chamber.

As is quite usual, the claims of the original patent were retained in the reissue, and the "inadvertence, accident or mistake" which resulted in their inadequacy was cured by the submission of two additional claims (numbered 8 and 9) which were allowed by the Patent Office, and which alone are involved in this case.

It is believed to be unnecessary to analyze the process recited by these two claims, as that was done carefully and fully by the District Court (R. I, pp. 4-5), and was reproduced in the opinion of the Court of Appeals (R. II, p. 179).

For our present purpose of crystallizing the point which is in dispute, and upon which Petitioner's Brief is concentrated with respect to the first question it presents to this Court, we merely call attention to the fact that in *each* of these claims the process of the invention is recited as comprising "forming a mixture containing ethylene and molecular oxygen", and causing that mixture to react in a reaction zone maintained at a specified temperature, in the presence of the catalyst, and "*in the presence of water*" (line 34 of claim 8; and line 25 of claim 9).

From this it will be seen that the two claims added to the reissue patent are directed, specifically and expressly, to the *same* invention as that described in the original patent, and that they *each* recite all of the necessary elements or conditions enumerated on page 5 of this brief, which everyone is agreed are necessary to effect the direct oxidation of ethylene to produce ethylene oxide by the patented process.

With the simple indisputable facts of the case thus recited, we proceed to the merits of the first point of argument presented by petitioner, reserving until later the statement of such additional facts as may be necessary for consideration in discussing petitioner's second point.

Summary of Argument.

1. Claims 8 and 9 of the reissue patent are for the same invention as that of the original patent.
2. Petitioner has acquired no "intervening rights" which, legally or equitably, justified the deliberate construction of a commercial plant, started more than a year after the grant of the reissue patent and with knowledge thereof, or the subsequent commercial operation of the plant in deliberate and conceded infringement.

ARGUMENT.

I.

Claims 8 and 9 of the reissue patent are for the same invention as that of the original patent.

The first point of argument of petitioner (Brief, p. 26) accurately frames the first issue presented by this case, and quite fittingly crystallizes what we regard as the error of the statement of the first question appearing on page 2 of Petitioner's Brief.

We agree that the sole question presented on this phase of the case is whether or not claims 8 and 9 of the reissue patent are *for the same invention* as that of the original patent.

We likewise agree with Petitioner's Brief, without qualification or reservation of any kind, that the law is that *if* claims 8 and 9 of the reissue patent are, in fact, for a *different invention* from that of the original patent, then those claims are invalid. On the other hand, we assert (and Petitioner's Brief implicitly is in agreement) that if claims 8 and 9 of the reissue patent in suit *are*, in fact, for the *same invention* as that of the original patent, then the claims are valid, and, infringement thereof having been conceded (Petitioner's Brief, p. 20), the judgment of the Court of Appeals below should be affirmed.

Whether or not claims 8 and 9 are for the same invention as that of the original patent is a simple question of *fact*, on which both the District Court and the Court of Appeals below are in complete accord. If the unanimity of opinion in the Courts below on this factual issue is not accepted as controlling and "unassailable", as it should be under

familiar legal principle, [10] the question can be easily and quickly settled by this Court by a simple comparison of the two documents.

From the foregoing analysis of their disclosures (*ante*, pp. 6-13) it is believed to be apparent and beyond dispute that the *invention* described by the specifications of both the original and reissue patents is *identical*. The invention in each is expressly recited, in one form of expression or another, as *the production of ethylene oxide by the direct oxidation of ethylene, or, synonymously stated, the combining of molecular oxygen with ethylene*. In *each* specification it is recited that this is effected by combining ethylene and molecular oxygen *in the presence of water* and the catalyst, under specified temperature conditions. In *each* case the necessary molecular oxygen is obtained from *air*, which, concededly, and as a matter of common knowledge, also contains the necessary water.

In *both* the original and reissue patents the necessity for the presence of water to *cause* the desired reaction is expressly recorded. In *each* of the patents there is expressed the *optional* possibility of utilizing *additional* water to *facilitate* the reaction, or to increase the *efficiency* thereof and to check the formation of undesirable side reaction products.

In other words, there is a complete and literal identity of substance between the invention shown and described in the original patent and the invention shown and described in the reissue patent.

In a similar manner, it will be seen that there is complete identity of the invention *claimed* by the original patent and that recited in claims 8 and 9 of the reissue. Each of claims 8 and 9 expressly recites that at the specified tem-

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[10] *Adamson* v. *Gilliland*, 242 U. S. 350.

perature the reaction between ethylene and oxygen takes place "*in the presence of water*" and the catalyst. This language is almost verbatim the same as the language contained in the claims of the original patent which recite (e. g. claim 1) that the ethylene is subjected

> "to the simultaneous action of oxygen and water, in the presence of a catalyst".

Indeed, it will be seen, on an examination and detailed comparison between claims 8 and 9 and the claims of the original patent (e. g. claims 1, 2 or 3), that the *only* difference between them is a change in the designation of the catalyzer to "a material having the catalytic characteristics of silver" (claim 8), or "catalyst material composed essentially of silver" (claim 9).

The entire propriety and want of significance in this change of designation of the catalyzer is not only shown by the specifications of both the original and reissue patents (*each of which specifies silver alone as a usable catalyst*), but it is also expressly conceded by petitioner (Petitioner's Brief, first paragraph p. 6).

In consequence, respondent asserts as an indisputable and dispositive fact—found by both of the Courts below to be the fact—that claims 8 and 9 of the reissue are for *the same invention* as that described and claimed by the original patent. Indeed, as the Court of Appeals below pointed out (R. II, p. 183):

> " • • • if claims #8 and #9 of the reissue patent had been added to the claims of the original patent, we do not believe these claims could have been held to be invalid on the ground that these claims were not sufficiently covered by the specifications of the original patent."

As this Court has had occasion to note (*Seymour* v. *Osborne*, 11 Wall 516, at pp. 545-546) in a technical chem-

ical case of this character, the opinion of skilled workers in the art is of particular value and importance. Here, the foregoing finding of fact by both of the Courts below was unanimously supported by the testimony of Dr. Lamb (R. I, p. 249), Dr. Stevenson (R. II, pp. 25, 43-44) Dr. Frazer (R. II, p. 85), Dr. Curme (R. II, pp. 62-63) and Dr. Law (R. II, pp. 52-53).

Petitioner's argument before this Court is based on a fundamental error of fact.

Petitioner's entire case on the issue under discussion is predicated upon the assertion (reflected in the error of statement of the first question presented on page 2 of its Brief) that the original patent included as a step of the process *the mandatory introduction of water* into the reaction chamber, whereas the reissue makes the introduction of water *permissive*. It readily will be seen from what has already been said that this is quite an erroneous conception, and certainly an incorrect description of the two patents. *In both of the patents the presence of water is specifically stated in the specifications and in the claims to be necessary for the reaction to produce ethylene oxide.* In *both* of the patents the presence in the reaction chamber of the necessary water and the necessary oxygen, and the mandatory introduction of both, is effected by *the introduction of air*. *Each* of claims 8 and 9 of the reissue *expressly* recites that the reaction takes place *"in the presence of water."* *Each* of the claims of the original patent recites that the ethylene is subjected to the *"simultaneous action of oxygen and water"*. It is apparent, therefore, that the presence of the necessary water in the reaction chamber, as well as its introduction thereto, is just as *mandatory* in the reissue patent

as it is in the original. In consequence, petitioner's error of *fact* is made crystal clear.

What petitioner is attempting to do is to confuse the water which is mandatorily present, and which is supplied by the introduction of *air* into the reaction chamber, with the *additional* water which, as we have seen, is described by *both* patents as being *optionally* usable to increase the "efficiency" of the reaction or to enable the reaction to be "facilitated" and the production of undesirable by-products checked.[11] *Both* the original and reissue patents make it clear beyond question that this *additional* water is something wholly distinct or apart from the water which mandatorily must be present in the reaction chamber and is introduced, with oxygen, as a constituent of air.

Petitioner's infringing operations meet every *mandatory* requirement of *both* of the patents. With respect to the *mandatory* introduction of water into the reaction chamber, page 18 of Petitioner's Brief recites:

> "Petitioner is engaged in the commercial production of ethylene glycol in its manufacturing plant at Baltimore, Maryland. As one of the steps in such manufacture, ethylene oxide is produced by passing a gaseous mixture of ethylene *and the constituents of atmospheric air (including a substantially normal water vapor content*, R. Vol. I, p. 279) through a chamber containing a catalyst consisting of silver disposed upon a carrier of aluminum oxide bonded by a fusion process, the mixture being passed continuously through the chamber in intimate contact with the catalyst through an extended period of time. Throughout the operation the temperature within the

[11] As part of its effort to this end, petitioner suggests, by a footnote on page 45 of its Brief, that the possibility of dispensing with the "introduction" of *additional* water was not discovered by the inventor until years later. This, of course, is not so, as has already been shown and as was concurrently found by the Courts below.

chamber is maintained between 150° and about 400° C. As a result, ethylene oxide is produced in substantial amount, and the resulting gaseous mixture containing the ethylene oxide is passed out of the chamber continuously during the operation."[12]

Compare this description, in words of petitioner's selection, with the statement of invention of the original patent in its opening paragraph. Petitioner's statement is:

> "• • • passing a gaseous mixture of ethylene and the constituents of *atmospheric air* (*including a substantially normal water vapor content* • • •) through a chamber containing a catalyst • • • ".

The statement of the original patent is:

> "• • • subjecting ethylene to the simultaneous action of the *oxygen* of air *and* of *water*, in the presence of a catalyst • • • ".

Despite the obvious and indisputable identity between petitioner's statement of its process and the statement of the original patent above quoted, petitioner asserts that the original patent is for an invention *different* from that of the reissue patent *the infringement of which is conceded* (Petitioner's Brief, p. 20). As a matter of simple logic, it will be seen that infringement by petitioner of claims 8 and 9 of the reissue patent could result *only* because they claim the same invention as that of the original patent be-

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[12] This statement of petitioner's process in Petitioner's Brief is a paraphrase of the stipulated description of petitioner's process constituting Plaintiff's Exhibit 7 (R. I, p. 279). The exhibit further states:

> "The gaseous mixture entering the chamber contained usually about 1.5% by volume of water vapor, not exceeding 1.7% by volume at any time."

If petitioner eliminated all water it would not infringe (R. II, p. 32).

cause of the identity between petitioner's process and that of the original patent as above shown. The precise and exact science of mathematics teaches that when two things (the original and reissue patents) are each identical with the same thing (petitioner's process) they, themselves, are identical.

It should now be quite obvious that the reason why petitioner's operation was not an infringement of claims 1 to 7 of the original patent was *not* because of the difference between *mandatory* or *voluntary* introduction of water, as petitioner argues, but was solely because of the two simple facts:

(1) that the silver catalyst used by petitioner did not consist of a *mixture* of silver, *with* gold, copper or iron (claim 1), or a *mixture of* silver, gold, copper and iron (claim 2), or a *mixture of* silver and gold (claims 3 and 6), or a *mixture of* silver, gold and copper (claim 7), *although the patent states that "silver alone" was a catalyst that could be used in the process constituting its invention;* and

(2) that petitioner did not introduce hydrogen into the reaction chamber (claims 4 and 5), *although such introduction of hydrogen was stated by the patent to be entirely optional.*

Consequently, it is submitted that petitioner's first point of argument is based on a wholly erroneous statement or assumption of fact, and is entirely without merit. Essentially, it reduces itself to the mere contention that a reissue patent, which claims an invention identical in every vital, essential, substantial and material respect with that of the original patent, is void because it is not "for the same

invention" as that of the original patent.[13] We have heretofore studiously refrained from citing authority on this issue because there is no dispute or issue of law here involved, but petitioner's contention is so illogical and so contrary to all of the decisions of this Court on this precise point that we venture the citation of an early and a late case showing the consistent opinion of this Court throughout the years that identity of invention between original patents and their reissues is established by *substance* and not merely by words (*Bates* v. *Coe*, 98 U. S. 31; *Abercrombie & Fitch Co. et al.* v. *Baldwin et al.*, 245 U. S. 198).

It follows that claims 8 and 9 of the Lefort reissue patent are valid.

II.

Petitioner has acquired no "intervening rights".

Respondent here records complete recognition of the doctrine of intervening rights, and characterizes it as a most salutary doctrine as well as a necessary curb on improper use of the Reissue Statute by patentees who seek to broaden a patent, after its grant, so as to include within its monopoly commercial operations of a competitor which were free from the monoply of the original patent, and were actually engaged in by the competitor before application for the reissue was filed. In other words, respondent does not dispute the simple proposition of law that if petitioner's commercial operations had been conducted prior to the application for the reissue patent on September 25, 1936, then the reissue patent could not be utilized to prevent petitioner from continuing those commercial operations.

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[13] Both of the Courts below found that the inventions of the original and reissue patents were identical in every "vital, essential, substantial and material" respect (R. II, p. 177).

Here again, however, whether or not petitioner is possessed of "intervening rights" is dependent solely upon the chronological facts of the case, none of which is in dispute. For convenience they are here marshalled.

1. Application for the original Lefort patent was filed on March 22, 1932.

2. Petitioner first became familiar with the Lefort invention in 1933, through acquisition of copies of the French patents on which the United States application was based (R. I, p. 189).

3. Petitioner allegedly began, in January, 1934, "research and development work", which it says ultimately resulted in its commercial infringement (Petitioner's Brief p. 19).[14]

4. *The original Lefort patent was issued on April 23, 1935.*

5. *The application for the reissue patent was filed on September 25, 1936.*

6. *After the application for reissue was filed*, namely "by the *end of 1936*" an experimental process allegedly had been "developed" by the petitioner which it was *believed* could be used commercially (Brief, p. 19).[15]

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[14] Although petitioner alleges that it began research and development work in January, 1934, to produce ethylene oxide by direct oxidation, the fact is that its early work had nothing whatever to do with a catalytic process, because its chemist, Mr. Carter, in charge of this research work, admitted that he had had "relatively little experience" in the art of catalysis until the Fall of 1935 (R. I, p. 196); and the first record produced by petitioner of even an experiment of that character was in February 1935 (R. I, p. 197). His *next* experiment was in December 1935 (R. I, p. 200). Both were failures (R. I, p. 203).

[15] Although Petitioner's Brief vaguely fixes this time as "the end of 1936", it was expressly admitted that *this was subsequent to the application for the reissue patent* (R. I, p. 203).

7. *Seven months after the application for reissue was filed,* namely, in April 1937, *plans* for an *experimental* "pilot" unit were *started* by petitioner, and "*estimates* for a commercial plant were *undertaken*" (Brief, p. 19).

8. *The reissue patent was granted on May 18, 1937.*

9. *After the grant of the reissue,* the construction of petitioner's experimental "pilot" unit was started (R. I, p. 224). It was completed and *first operated* "in the middle of 1937" (Brief, p. 19).

10. *A year after the grant of the reissue* "construction of petitioner's commercial plant near Baltimore, Maryland, was *undertaken* in the middle of *1938*" (Brief, p. 19).

11. *Two years after the grant of the reissue,* petitioner's commercial plant was *completed* and *first put in operation on May 9, 1939* (Brief, p. 19).

To the foregoing may be added:

12. Petitioner, concededly, was familiar with the original Lefort patent shortly after its issuance (R. I, p. 189).

13. Petitioner, concededly, was familiar with the reissue patent immediately after its grant (R. I, p. 228).

From the foregoing it will be seen that the relevant facts are few and simple. They all boil down to the simple statement that *petitioner did not begin the construction of its plant, in which its infringing operations are conducted, until more than a year after the reissue patent was granted, and did not begin its infringing operations in its plant until two years after the reissue patent was granted; and that all this was done with full knowledge of the existence of the*

reissue patent, and the realization that the proposed operations would be in infringement thereof.[16]

Moreover, petitioner's appropriation of the invention of the Lefort patent, and the deliberate infringement thereof, were elected in studied and deliberate preference to the utilization of another and different process currently used in the industry for producing ethylene oxide, and which petitioner had been advised by its patent counsel was patent-free and available for adoption (R. I, 228, 229).

It would seem to be conclusive, therefore, that petitioner is possessed of no intervening rights.

However, petitioner advances what it characterizes as a *novel* proposition of law, namely, that because it had conducted some *experiments* prior to the grant of the reissue, the doctrine of intervening rights should be extended so as to include mere experimentation within its principle, and place mere intervening *experimentation* on the same footing as intervening *commercial operations* to which, for obvious reasons, the doctrine necessarily is limited. Petitioner's suggested extension of the doctrine would permit one who has merely *experimented* between the grant of an original patent and an application for reissue thereof to *initiate* and engage in infringing *commercial operations subsequent to the grant of the reissue.*

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[16] Petitioner's Brief repeatedly asserts (*e. g.* p. 19) that its "expenditures upon the research and development work from its inception up to September 25, 1936 when the application for reissue of the patent in suit was filed, totaled about $132,000, and its further expenditures on this research up to May 18, 1937, when the reissue patent was granted, totaled $19,000, an aggregate of $151,000". While we do not regard this fact, if it be a fact, to be material to any question before this Court, it should be noted (and it was commented upon by the Courts below), that there is not one word of evidence which shows, or tends to show, how much, if any, of this amount was expended for experiments on a catalytic process for producing ethylene oxide, or one in any other respect relevant to the process of the Lefort patent which petitioner ultimately adopted.

We agree that such an extraordinary proposition is certainly novel, and we assert that it is quite illogical from a legal viewpoint, even if founded on a factual basis, which it is not in the present case.

In the first place, it is well settled that *any* intervening rights which might accrue, *must* accrue prior to the *filing* of the application for the reissue (Walker on Patents, Deller's Edition, Volume II, p. 1384). As seen from the foregoing chronology, the application for reissue was filed on September 25, 1936; *and this, concededly, was prior to the time that petitioner alleges it had succeeded, in its experiments, in developing a process which it believed could be commercially utilized* (Petitioner's Brief, p. 19). Therefore, it is quite obvious that petitioner acquired no "rights" of a nature with which this case is concerned, under the "intervening rights" doctrine, either as it exists, or if extended in the extraordinary manner petitioner suggests.

In the next place, it would seem to be obvious that any "rights" that one would acquire under such circumstances, to be characterized as "intervening rights" in the sense petitioner uses the term, must, necessarily, be of the *same* character as those which were created by factual activity. In other words, the "intervening rights" which this Court has had occasion to pass upon (Cf. *Sontag Chain Stores Co.* v. *National Nut Co.*, 310 U. S. 281), in *every* instance have been *commercial* "rights" which were created by actual *commercial* operations in the period intervening between the grant of the original patent and the application for the reissue. By a logical application of the doctrine it would seem to be apparent that the only "right" acquired by one engaged in *experimentation* between the grant of an original patent and the application for reissue, would be the right of *experimentation* after grant of the reissue. The obvious reason why no such application of the doctrine has

reached judicial notice is because of the elementary fact that mere experimentation of this kind does not constitute an infringement of a patent grant, regardless of when it occurs (Cf. *Oppenhusen* v. *Falke* (1861), 2 Fisher 181; 4 Blatch. 493; *Poppenhusen* v. *New York Gutta Percha Comb Co.* (1858), 2 Fisher 62; *Frearson* v. *Loe* (1878), L. R. 9; Ch. D. 48.

The decision of the Second Circuit Court of Appeals in *Otis Elevator Co.* v. *Atlantic Elevator Co.*, 47 F. (2d) 545, is cited by Petitioner's Brief (p. 50) as alone supporting its unusual contention. A reading of the entire opinion shows, conclusively, that it does not. Indeed, a reading of the portion thereof quoted on page 50 of Petitioner's Brief gives the clue to its actual holding. In that case application for reissue was not filed until "seven and a half years after the original patent issued" (p. 548), and during that period not only had the *experimental* installations "at Los Angeles, Chicago, and Pittsburgh" been made, but there also had been made a *commercial* installation in a building at Cleveland which installation was "*completed before the application was filed*".

From this it will be seen that in that case the doctrine of "intervening rights" was sustained by the Court, not because of intervening *experimentation*, as petitioner suggests, but because of intervening *commercial* activity *prior to the filing of the application for reissue*—both of which essential factors are entirely absent in the present case.

In view of the foregoing, it is abstractly submitted that petitioner's suggested extension of the doctrine of "intervening rights" is wholly without logical support or legal justification. However, and as before pointed out, further discussion thereof is unnecessary because, in any event, the doctrine, as it stands or as petitioner would extend it, has no application here in view of the facts of this case.

In conclusion on this issue, we ask the Court to read the short passage of the opinion of the District Judge (R. I, pp. 19-20), wherein it was stated, in view of the undisputed facts of the case:

> "• • • it is difficult to understand how this contention can be seriously made";

and we likewise commend to this Court the statement of the Court of Appeals with respect thereto (R. II, p. 185), namely:

> "Defendant is here clutching for a very feeble straw."

It is submitted, therefore, that petitioner's second point of argument is utterly wanting in merit.

Conclusion.

The case at bar brings to this Court the first instance in many years of a patented invention, the stature of which commands the respect due genius. We have shown that claims 8 and 9 of the reissue patent in suit are for the invention disclosed in the original patent grant; that deliberate infringement of these claims has been conceded; and that petitioner is not possessed of any "intervening" or *other* "rights" with respect thereto. In consequence, the judgment of the Court of Appeals below should be affirmed.

Respectfully submitted,

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IN THE

Supreme Court of the United States

OCTOBER TERM, 1941

No. 680

U. S. INDUSTRIAL CHEMICALS, INC.,
Petitioner,

vs.

CARBIDE AND CARBON CHEMICALS CORPORATION,
Respondent.

APPENDIX I TO BRIEF FOR RESPONDENT

Fox Printing Company, Inc., 80 Lafayette Street, New York, N. Y.

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APPENDIX I.

DIGEST OF DECISIONS OF THIS COURT IN REISSUE PATENT CASES 1832 TO 1940

THE STATUTE.

Authority for surrender of a defective original patent and for the grant of a corrected reissue patent is provided by Revised Statute §4916 (U. S. C., title 35, sec. 64):

"Whenever any patent is wholly or partly inoperative or invalid, by reason of a defective or insufficient specification, or by reason of the patentee claiming as his own invention or discovery more than he had a right to claim as new, if the error has arisen by inadvertence, accident, or mistake, and without any fraudulent or deceptive intention, the commissioner shall, on the surrender of such patent and the payment of the duty required by law, cause a patent for the same invention, and in accordance with the corrected specification, to be reissued to the patentee or to his assigns or legal representatives, for the unexpired part of the term of the original patent. Such surrender shall take effect upon the issue of the reissued patent, but in so far as the claims of the original and reissued patents are identical, such surrender shall not affect any action then pending nor abate any cause of action then existing, and the reissued patent to the extent that its claims are identical with the original patent shall constitute a continuation thereof and have effect continuously from the date of the original patent. The commissioner may, in his discretion, cause several patents to be issued for distinct and separate parts of the thing patented, upon demand

of the applicant, and upon payment of the required fee for a reissue for each of such reissued letters patent. The specifications and claims in every such case shall be subject to revision and restriction in the same manner as original applications are. Every patent so reissued, together with the corrected specifications, shall have the same effect and operation in law, on the trial of all actions for causes thereafter arising, as if the same had been originally filed in such corrected form; but no new matter shall be introduced into the specification, nor in the case of a machine patent shall the model or drawings be amended, except each by the other; but when there is neither model nor drawing, amendments may be made upon proof satisfactory to the commissioner that such new matter or amendment was a part of the original invention, and was omitted from the specification by inadvertence, accident, or mistake, as aforesaid."

The statutory prerequisites are thus:

1. The original shall be at least partially inoperative or invalid by reason of a defective or insufficient specification or by reason of the patentee claiming as his own invention or discovery more than he had a right to claim as new.

2. The error of the original shall have arisen

(a) by inadvertence, accident or mistake,

(b) and without any fraudulent or deceptive intention,

3. The reissued patent shall be for the same invention and in accordance with the corrected specification.

ADDITIONAL PREREQUISITES

This Court, in the course of deciding many cases under the statute, has announced as further implicit prerequisites of a valid reissue:

1. There shall be no unreasonable delay in applying for reissue.

2. Application for the reissue, if to broaden the patent claim, shall be made within two years* of the grant of the original patent.

3. The "same invention" patented by the reissue shall be subject matter substantially indicated in the original patent and therein indicated as intended to be subject matter invented and claimed by the patentee.

RESUME OF DECISIONS OF THIS COURT

It is believed that several broad principles run harmoniously through all the reported Reissue cases from 1832 to date. These are briefly stated as follows:

Settled Principles Regarding Inoperativeness or Invalidity of Original Patent by Reason of Defective or Insufficient Specification

It is established that this prerequisite embraces a failure of the original patent fully to *protect* the true invention as well as a failure correctly to *describe* it.

The failure of *protection* may arise from the original claims being too *narrow* or from the original claims being too *broad*. The failure of *description* may be one of deficiency or excess.

* Perhaps now, by analogy, one year (Act of August 5, 1939; 53 Stat. 1212) as to reissue of patents applied for since *August 5, 1940*.

Settled Principles Regarding Inadvertence, Accident or Mistake and Without Fraudulent or Deceptive Intention

The defect of the original patent must have occurred innocently by circumstances of inadvertence, accident or mistake justifying relief by a court of equity.

The file-wrapper of the original patent, showing its course through the Patent Office, may be examined, particularly where the defect concerns the factor of scope of protection. For example, where the reissue claims broaden the protection, it must appear that the undue narrowness of the original claims was not made with forethought necessarily to distinguish from the prior art.

On the other hand, where the defective narrowness of the claims of the original patent has arisen from an error partly or wholly chargeable to the Patent Office or from an explainable and not unreal error chargeable to the patentee, the situation is proper for correction by reissue.

The file wrapper of the reissue application together with other evidence may be considered in explanation of the occurrence of the defect of the original.

The Commissioner of Patents has the responsibility of passing on the fact question of whether the defect of the original arose from inadvertence, accident or mistake, and the Commissioner's action in granting the reissue is conclusive on that question in the absence of fraud.

Settled Principles Regarding "Same Invention"

I.

The reissue statute is remedial, and it essentially requires good faith compliance with all the prerequisites. Accordingly, the motive for the reissuance is an important preliminary inquiry in reaching judgment.

Reissue for the purpose of effectuating *protection* of the patentable subject matter disclosed, and indicated as intended to be asserted as the patentee's invention, by the original patent is consistent with the reissue patent being for the same invention and is indicated by the fact that discovery of the defect does not arise after, and from knowledge of, another's independent and different operations, and by the fact that the remedy sought is not motivated to entrap such interim operations.

On the contrary, reissue for the purpose of describing a material difference in subject matter, or of embracing within the claims a materially different and particularly an originally unknown thing, is inconsistent with the reissue patent being for the same invention.

II.

In judging whether the original and reissue patents are for the same invention, it is necessary to determine what the true inventive subject matter in the original patent was, and this inquiry involves an appraisal of the novelty and utility of the invention against the background of the prior art and against the foreground of its effect on its art, whereby the invention may be properly ranked as a narrow improvement or as radically new, and as contributing to the progress of the art or as without commercial affect.

III.

The factors of identity and difference between the original and reissue patents, by which the question of whether or not the patents are for the "same invention" is to be resolved, can sometimes be identified and evaluated in the case of simple and easily understandable inventions from a comparison of the original and reissue patents themselves.

These factors and their evaluation in the case of abstruse inventions are to be determined in the light of testimony of workers skilled in the particular art involved regarding what the patents disclose to them, as well as in the light of direct comparison of the original and reissue patents themselves.

In judging the legal effect of differences between an original patent and its reissue patent, it must preliminarily be determined what their functional significance is. In other words, the preliminary inquiry must be as to whether or not, *to the skilled worker in the art,* these differences are essential or necessary or vital or substantial or material with respect to the integrity of the thing under inquiry.

The question of whether the differences are matters of essence (and thus fall in the category which makes the reissue not for the same invention), or immaterialities (and thus fall in the category which makes the reissue still for the same invention) is determined in the light of

(a) definitions and statements made by the original patent and the reissue patent themselves

(b) evidence of the understanding of the subject matter imparted by the patents to workers skilled in the special art, *i. e.*, by expert testimony

(c) a comparison between the subject matter described by the original patent and the subject matter constituting the defendant's alleged infringement of the reissue patent

(d) whether the claims of the reissue could have been made on the description contained in the original patent, or on the contrary rested only on the altered description of the reissue patent

(e) an evaluation of the subject matter–including the differences, and determination whether such subject matter was patentable independently over the subject matter excluding such differences.

Whether the differences are of the character (as to subject matter) which makes the reissue for the same invention as the original, or in the category (as to subject matter) which makes the reissue not for the same invention, is a question of fact.

The legal effect of the differences between the original patent and the reissue patent is a question of law. If the differences are essential, or necessary, or vital, or substantial, or material, the reissue is not for the same invention and hence is invalid. If the differences are non-essential, or unnecessary, or immaterial, or insubstantial, then the reissue is, in law, for the same invention and hence valid.

THE DECISIONS ON REISSUE PATENTS

GRANT v. RAYMOND, 31 U. S. 217 [1832]

Interval—4 years

Motive of Reissue—This was a case antedating any statutory provision for patent reissue. Nevertheless, since the original was discovered to be defective, it had been surrendered and a new patent issued.

Subject Matter—Manufacture of Hat Bodies

HELD

"The laws which are passed to give effect to this purpose ought, we think, to be construed in the spirit in which they have been made; and to execute the contract fairly on the part of the United States, where the full benefit has been actually received; if this can be done, without transcending the intention of the statute, or countenancing acts which are fraudulent, or may prove mischievous. The public yields nothing which it has not agreed to yield; it receives all which it has contracted to receive. The full benefit of the discovery, after its enjoyment by the discoverer for fourteen years, is preserved; and for his exclusive enjoyment of it, during that time, the public faith is pledged. That sense of justice and of right which all feel, pleads strongly against depriving the inventor of the compensation thus solemnly promised, because he has committed an inadvertent or innocent mistake.

If the mistake should be committed in the department of state, no one would say, that it ought not to be corrected. All would admit, that a new patent, correcting the error, and which would secure to the patentee the benefits which the law intended to secure, ought to be issued. And yet

the act does not, in terms, authorize a new patent, even in this case. Its emanation is not founded on the words of the law, but is indispensably necessary to the faithful execution of the solemn promise made by the United States. Why should not the same step be taken, for the same purpose, if the mistake has been innocently committed by the inventor himself?" (240-242)

"If, by an innocent mistake, the instrument introduced to secure this privilege fails in its object, the public ought not to avail itself of this mistake, and to appropriate the discovery, without paying the stipulated consideration. The attempt would be disreputable in an individual, and a court of equity might interpose to restrain him." (243)

STIMPSON v. WESTCHESTER RAILROAD CO., 45 U. S. 379 [1846]

Interval—4 years

Motive of Reissue—Modification of claim to dominate interim construction.

Subject Matter—The original was for an arrangement of wheel flanges on one side of railroad cars and of the wheel treads on the other side to allow short radius turns.

HELD

"Whether the new patent was substantially for a different invention from the first one, was a question for the jury on the evidence." (403)

O'REILLY, *et al.* v. MORSE, 56 U. S. 61 [1853]

Interval—8 years

Motive of Reissue—Modifying claims to effectuate protection.

Subject Matter—This was the basic Morse telegraph invention.

HELD

"Regarding Professor Morse as the first and original inventor of the Telegraph, we come to the objections which have been made to the validity of his patent.

We do not think it necessary to dwell upon the objections taken to the proceedings upon which the first patent was issued, or to the additional specifications of the reissued patent of 1848. In relation to the first, if there was any alteration at the suggestion of the commissioner, it appears to have been a matter of form, rather than of substance; and, as regards the second, there is nothing in the proof or on the face of the reissued patent to show that the invention therein described is not the same with the one intended to be secured by the original patent. It was reissued by the proper lawful authority; and it was the duty of the commissioner of patents to see that it did not cover more than the original invention. It must be presumed, therefore, that it does not, until the contrary appears. Variations from the description given in the former specification do not necessarily imply that it is for a different discovery. The right to surrender the old patent, and receive another in its place, was given for the purpose of enabling the patentee to give a more perfect description of his invention, when any mistake or oversight was committed in his first. It necessarily, therefore, varies from it. And we see nothing in the reissued patent

that may not, without proof to the contrary, be regarded as a more careful description than the former one, explaining more fully the nice and delicate manner in which the different elements of power are arranged and combined together and act upon one another, in order to produce the effect described in the specification." (111-112)

BATTIN v. TAGGERT, 58 U. S. 74 [1854]

Interval—6 years

Motive of Reissue—To alter subject matter of claim

Subject Matter—The original claimed a combination of breaking rollers and screen for coal. The reissue claimed the breaking rollers only and of a particular construction.

HELD

"Whether the defect be in the specifications or in the claim, under the 13th section above cited, the patentee may surrender his patent, and, by an amended specification or claim, cure the defect. The reissued patent must be for the same invention, substantially, though it be described in terms more precise and accurate than in the first patent. Under such circumstances, a new and different invention cannot be claimed. But where the specification or claim is made so vaguely as to be inoperative and invalid, yet an amendment may give to it validity, and protect the rights of the patentee against all subsequent infringements." (82)

"The plaintiff, by a surrender of that patent, and the procurement of the patent of 1849 with amended specifications, abandoned his first patent, and relied wholly on the

one reissued. The claim and specifications in this patent, as amendatory of the first, were within the 13th section of the act of 1836. It is said; with entire accuracy, in the charge, in regard to the amended specification of the patent of 1849, that it 'described essentially the same machine as the former one did, but claimed, as the thing invented, the breaking apparatus only.' And this the patentee had a right to do. He had a right to restrict or enlarge his claim, so as to give it validity, and to effectuate his invention." (83-84)

"The jury are also to judge * * * whether the renewed patent is for the same invention as the original patent; * * *." (84)

BURR v. DURYEE, 68 U. S. 531 [1863]

Interval—14 years

Motive of Reissue—To enlarge both disclosure and claim to dominate interim device

Subject Matter—The original narrowly claimed particular elements and arrangements of a fiber hat body machine. The reissue broadly claimed a combination of three elements.

HELD

1.

"Let us consider what was the original invention of Wells, as described and claimed by himself, without regard to this ingenious attempt by the assignee to expand it into an abstraction.

It is not within the category of those inventions which consist in a new application of certain natural forces to

produce a certain result to which they had never before been applied, and which, when once pointed out, required no invention to construct devices for its application. Such inventions partake of the nature of discoveries, either found out by experiment or the result of a happy thought, which, when once expressed, is plain to all intelligent persons, who could point out at once many devices for making it effectual. Any one can perceive the difference of such a case from the invention of a labor-saving machine, which is a mere combination of certain mechanical devices to produce a desired manufacture in a cheaper or better manner." (568)

"It is plain that the invention of Wells had nothing of the nature of a discovery, or the new application of some power of nature to the perfection of an art or the operation of a machine, such as the application of the electro-galvanic fluid to the art of telegraphic writing. It was simply a concrete machine, an improvement on other known machines, and nothing more." (569)

2.

"The original patent of Wells has been more than once decided by the courts to be a valid patent. The specification states clearly and correctly what the invention is; what the patentee claims as his peculiar improvement on former machines; what are the devices, or peculiar combination of them, which make it to differ, and the mode in which they operate to produce the required result. He claims all he had a right to claim as new, and no more. There is no error from 'inadvertence, accident, or mistake.'" (571)

3.

"Now, the machine of Boyden has not one of the peculiar devices, or combination of devices, of the Wells machine, nor any substantial identity with it, unless by substantial identity is meant every machine which produces the same effect. These abstract phrases, '*substantial* identity,' 'equivalent,' 'mode of operation,' &c., are often used in such a vague and equivocal manner, that they mystify and lead many to absurd conclusions, who will not distinguish between things that differ. That two machines produce the same effect, will not justify the assertion that they are substantially the same, or that the devices used by one are, therefore, mere equivalents for those of the other. There is nothing in the Wells machine or its devices which suggests the peculiar device employed by Boyden. His machine has no tunnel, no cap, no flap, nor any equivalent therefor, nor does it incorporate in its structure the substance of the first invention. There is nothing to be found in the specification of Wells which would ever suggest the peculiar device of the Boyden machine. As an improvement, it has more claim to originality than that of Wells." (572)

"The patent to Boyden was issued on the 10th of January, 1860. The complainants were invited to examine it. They did so, accompanied by their counsel and other experts. After this, the complainants surrendered their valid patent, or rather its reissue of 1856, and have another reissue, which is now contended to have been made so elastic or expanded that it may be used to suppress all other inventions which have been made or may be made to effect the same purpose." (573-574)

"We concur, therefore, in the decision of the Circuit Court, that the machine of Boyden is not an infringement of the invention of Wells; and if it be an infringement of the reissued patent, that patent is void." (577)

MOREY v. LOCKWOOD, 75 U. S. 230 [1868]

Interval—8 years

Motive of Reissue—Enlargement of claim to effectuate protection erroneously denied by Patent Office in granting original.

Subject Matter—The original claim was limited to a syringe in which the sac tubes and valve boxes were disposed in the same axial line. This original limitation was caused by an error of the Patent Office with respect to a prior art disclosure and a failure of the patentee originally to perceive the error. The reissue enlarged the claim to cover any arrangement of these elements.

HELD

"We do not doubt that the commissioner had full authority to grant the amendment; and, under the special circumstances of the case, it would seem to have been a duty, as the inventors were led into the error by himself, as may be seen from his letter when the patent was originally granted. The amendment was very material, as the language of the original claim tied the patentees down to a syringe, consisting of the parts mentioned, to an instrument in which they were arranged in an axial, or straight line; tying them down to the mere form of the construction, regardless of the substance and legal import of the invention. While the original specification and claim remained, it was competent

for any one to evade the patent, and enjoy the substance of the improvement by a change in the mere form of the construction; that is, by an arrangement of the several parts in any form, if not in an axial or straight line. And this is what the defendants are endeavoring to accomplish, and would have accomplished, if the amendment of the claim had not been allowed." (240-241)

RUBBER COMPANY v. GOODYEAR, 76 U. S. 788 [1869]

Interval—16 years

Motive of Reissue—To claim product instead of process

Subject Matter—This involved the basic Goodyear vulcanization patent

HELD

"But liberality, rather than strictness, should prevail where the fate of the patent is involved, and the question to be decided is whether the inventor shall hold or lose the fruits of his genius and his labors." (795)

BISCHOFF v. WETHERED, 76 U. S. 812 [1869]

Subject Matter—This was not a reissue patent. However, the Court passed on the issue of same invention and the character of relevant evidence.

HELD

"A case may sometimes be so clear that the court may feel no need of an expert to explain the terms of art or the descriptions contained in the respective patents, and may, therefore, feel authorized to leave the question of identity

to the jury, under such general instructions as the nature of the documents seems to require. And in such plain cases the court would probably feel authorized to set aside a verdict unsatisfactory to itself, as against the weight of evidence. But in all such cases the question would still be treated as a question of fact for the jury, and not as a question of law for the court. And under this rule of practice, counsel would not have the right to require the court, as matter of law, to pronounce upon the identity or diversity of the several inventions described in the patents produced. Such, we think, has been prevailing rule in this country, and we see no sufficient reason for changing it. The control which the courts can always exercise over unsatisfactory verdicts will enable them to prevent any wrong or injustice arising from the action of juries; whereas, if the courts themselves were compellable to decide on these often recondite and difficult questions, without the aid of scientific persons familiar with the subjects of the inventions in question, they might be led into irremediable errors, which would produce great injustice to suitors. We are disposed to think that the practice adopted by our courts is, on the whole, the safest and most conducive to justice.

It may be objected to this view that it is the province of the court, and not the jury, to construe the meaning of documentary evidence. This is true. But the specifications of patents for inventions are documents of a peculiar kind. They profess to describe mechanisms and complicated machinery, chemical compositions and other manufactured products, which have their existence *in pais*, outside of the documents themselves; and which are commonly described by terms of the art or mystery to which they respectively belong; and these descriptions and terms of art often require peculiar knowledge and education to understand

them aright; and slight verbal variations, scarcely noticeable to a common reader, would be detected by an expert in the art, as indicating an important variation in the invention. Indeed, the whole subject-matter of a patent is an embodied conception outside of the patent itself, which, to the mind of those expert in the art, stands out in clear and distinct relief, whilst it is often unperceived, or but dimly perceived, by the uninitiated. This outward embodiment of the terms contained in the patent is the thing invented, and is to be properly sought, like the explanation of all latent ambiguities arising from the description of external things, by evidence *in pais*." (814-815)

"This view of the case is not intended to, and does not, trench upon the doctrine that the *construction* of written instruments is the province of the court alone. It is not the *construction of the instrument*, but the *character of the thing invented*, which is sought in questions of identity and diversity of inventions." (816)

SEYMOUR v. OSBORNE, 78 U. S. 516 [1870]

Interval—10 years

Motive of Reissue—Not stated

Subject Matter—Grain reapers

HELD

"Reissued letters patent must, by the express words of the section authorizing the same, be *for the same invention*, and consequently where it appears on a comparison of the two instruments, as matter of law, that the reissued patent is not for the same invention as that embraced and secured in the original patent, the reissued patent is invalid, as that

state of facts shows that the commissioner, in granting the new patent, exceeded his jurisdiction. Power is unquestionably conferred upon the commissioner to allow the specification to be amended if the patent is inoperative or invalid, and in that event to issue the patent in proper form; and he may, doubtless, under that authority, allow the patentee to redescribe his invention and to include in the description and claims of the patent not only what was well described before but whatever else was suggested or substantially indicated in the specification or drawings which properly belonged to the invention as actually made and perfected." (544)

"Corrections may be made in the description, specification, or claim where the patentee has claimed as new more than he had a right to claim, or where the description, specification, or claim is defective or insufficient, but he cannot under such an application make material additions to the invention which were not described, suggested, nor substantially indicated in the original specifications, drawings, or patent office model." (545)

"Letters patent reissued for an invention substantially different from that embodied in the original patent are void and of no effect, as no jurisdiction to grant such a patent is conferred by any act of Congress upon the commissioner, and he possesses no power in that behalf except what the acts of Congress confer. Whether a reissued patent is for the same invention as that embodied in the original patent or for a different one is a question for the court in an equity suit to be determined as a matter of construction, on a comparison of the two instruments, aided or not by the testimony of expert witnesses, as it may or may not appear that one or both may contain technical

terms or terms of art requiring such assistance in ascertaining the true meaning of the language employed.

Where the specification and claim, both in the original and reissued patents, are expressed in ordinary language, without employing any technical terms or terms of art, the question whether the reissued patent is for the same invention as that described in the original patent or for a different one is purely a question of construction, but where both or either contain technical terms or terms of art the court may hear the testimony of scientific witnesses to aid the court in coming to a correct conclusion. Cases doubtless arise where the language of the specification and claim, both of the surrendered and reissued patents, is so interspersed with technical terms and terms of art that the testimony of scientific witnesses is indispensable to a correct understanding of its meaning." (545-546)

CARLTON v. BOKER, 84 U. S. 463 [1873]

Interval—10 years

Motive of Reissue—Alteration of subject matter claimed, to dominate interim device

Subject Matter—The original narrowly claimed a lamp burner. The reissue changed the claim to cover a lighter of different construction.

HELD

The patent burner was "of little value". (465)

"Therefore, with these burners before us, all the invention we can discover in Reichmann's burner is the peculiar mode of supporting his dome by slender arms attached to a sleeve

fitted on to the wick-tube, and the elevation of the chimney on the outer edge of the dome. The latter peculiarity, as we have seen, is a defect which rendered the burner nearly useless." (468)

"We think it proper to reiterate our disapprobation of these ingenious attempts to expand a simple invention of a distinct device into an all-embracing claim, calculated by its wide generalizations and ambiguous language to discourage further invention in the same department of industry and to cover antecedent inventions." (471-472)

"The specification of the reissued patent describes the burner of Reichmann substantially as was done in the original patent, being interspersed, however, with observations as to the uses and objects of particular parts, evidently borrowed from subsequent experience and events. The single claim of the original patent is expanded into seven distinct claims." (471)

"Our conclusion, therefore, is that the Comet burner is no infringement of Reichmann's reissued patent so far as that patent is valid." (473)

GILL v. WELLS, 89 U. S. 1 [1874]

Interval—8 years

Motive of Reissue—To alter the description and radically change a claim to dominate interim device. [This was a further reissue of a former reissue passed on in *Burr* v. *Buryee*, 68 U. S. 31]

Subject Matter—Hat body machine.

HELD

1.

"Exact description of the invention was given in the specification of the original patent, which affords the most ample means to define the nature and scope of the improvement actually made by the patentee as secured by that patent." (16)

"Instead of that it is unquestionably true that the chamber or tunnel is a material ingredient of the combination and an essential feature of the described invention." (18)

2.

"Invalid and inoperative patents may be surrendered and reissued for the same invention, but Congress never intended that a patent which was valid and operative should be reissued merely to afford the patentee an opportunity to expand the exclusive privileges which it secures, to enable him to suppress subsequent improvements which do not conflict with the invention described in the surrendered patent." (19)

"Attention will next be called to the specification of the reissued patent as the best means by which to determine whether the invention secured by it is or is not the same as that of the original." (21)

"Material matters are left out of the specification when compared with the original, and it is beyond dispute that new features are introduced in the description of the devices to be employed in guiding the fibres of the fur when taken from the feeding mechanism by the rotating brush or picker." (21)

"Differences so wide between an original and a reissued patent show that it was a bold measure to grant, as well as to ask for, such a reissue. Examples of the kind, if any, it is believed are very few in which such a reissued patent has been granted where there is not a word in the original specification to support the theory that the patentee ever invented anything except his described combination, which it is admitted consisted of four ingredients, all of which were old. Complete description is given in the original specification of that combination, but the specification does not contain the slightest evidence that the patentee ever made any other combination than that which embodies the four described ingredients.

Cases arise where a patentee, having invented a new and useful combination consisting of several ingredients which in combination compose an organized machine, also claims to have invented new and useful combinations of fewer numbers of the ingredients, and in such cases the law is well settled that if the several combinations are new and useful, and will severally produce new and useful results; the inventor is entitled to a patent for the several combinations, provided that he complies with the requirement of the Patent Act and files in the Patent Office a written description of each of the alleged new and useful combinations, and of the manner of making, constructing and using the same.

He may give the description of the several combinations in one specification, and in that event he can secure the full benefit of the exclusive right to each of the several inventions by separate claims referring back to the description in the specifications; and if by inadvertence, accident, or mistake, he should fail to claim any one of the described combinations, he may surrender the original patent and have a reissue not only for the combination or combinations

claimed in the original, but for any which were so omitted in the claims of the original patent.

Very different rules, however, apply in a case where the only invention described in the original patent is the one which includes all the ingredients of the machine, provided there is no suggestion, indication, or intimation that any other invention of any kind has been made." (23-24)

"Enough has already been remarked to show that all the principal claims of the original patent recognize the chamber or tunnel and its appendages as one of the primary ingredients of the patented invention, and it is absolutely certain that the specification of that patent contains neither suggestion, indication, nor intimation that the original patentee made any other invention to accomplish the described functions than the one which includes the whole four described ingredients." (27)

"Viewed in the light of these several suggestions the court is of the opinion that it is not competent for a patentee, when he surrenders an original patent, to amend the specification for the new patent by striking out from the original the correct description of one of the ingredients of the patented combination, and to substitute in its place the description of other devices not well known at the date of the original patent as a proper substitute for the ingredient whose description is stricken out." (30)

THE CORN-PLANTER PATENT, 90 U. S. 181 [1874]

Interval—5 years

Motive of Reissue—The original patent was divided into five reissues

Subject Matter—The Court considered the prior art and held certain valid and certain invalid. The original

disclosed a plow frame, a roller frame, a pivotal connection between them and levers to lift the plow. It claimed this combination narrowly.

HELD

"A proper decision of the questions in these causes renders it necessary, in the first place, to ascertain, as near as may be, the actual date of Brown's alleged invention or inventions, such as and whatever they are." (203)

"We have thus gone over and explained, as well as the subject will admit, the various machines and inventions which constitute the history of the special art under consideration, up to the time that Brown's machine was produced. In the light of this review we are to determine the extent and character of his various patents and claims, and how far they are valid or void." (216-217)

"It may be remarked in passing that, in our view, the several reissues are for things contained within the machines and apparatus described in the original patents; but whether they were anticipated by prior inventions, or are void for any other reason applicable to patents and claims generally, is still open." (217)

COLLAR COMPANY v. VAN DUSEN, 90 U. S. 530 [1874]

Interval—3 years

Motive of Reissue—To introduce and claim new matter.

Subject Matter—The original patent claimed a collar of parchment paper coated with varnish. After issuance, the patentee spent money and effort to obtain satisfactory paper not disclosed in the original. When

one company consulted produced the desired result, the patentee sold his patent and reissue was applied for. The reissue introduced in considerable length and detail specifications for the new paper. The reissue set forth that the paper may or may not be parchment and may or may not be coated with varnish. It claimed merely a collar of long fiber paper, as distinguished from the claim of the original which was limited to a collar of parchment paper with a coating of varnish. In appraising the patent, the Court considered the prior art.

HELD

"* * * the purpose of a surrender and reissue is not to introduce new features, ingredients, or devices, but to render effectual the actual invention for which the original patent should have been granted." (557-558)

"Whether a reissued patent is for the same invention as the surrendered original or for a different one, must very largely be determined by a comparison of the two instruments, as the decision must necessarily depend upon the question whether the specifications and drawings of the reissued patent are not substantially the same as those of the original; and if not, whether the omissions or additions are or are not greater than the law allows to cure the defects of the original specification." (558)

"Attempt was made in that case [*Gill v. Wells*] to emasculate the combination described in the original patent by leaving out one of the material elements in order to give the exclusive right a more comprehensive effect in prosecuting suits for infringement, but in the case before the court the reissued patent is different throughout from the invention embodied in the original patent." (559)

"Apply that rule to the present case and it is clear that the original patentee was not entitled to a patent either for the paper or the process, as he never made any invention or discovery upon the subject." (564)

THE WOOD-PAPER PATENT, 90 U. S. 566 [1873]

Interval—9 years

Motive for Reissue—To enlarge claim and dominate interim invention.

Subject Matter—The patents were for a process to obtain pulp from wood or other vegetable substances for the manufacture of paper.

HELD

Undeniably three successive stages of operation were described in the specification, three distinct processes, not employed contemporaneously, but following each other in order of time. And this succession in the order mentioned was considered by the patentees as essential, in fact it was claimed as their invention. In support of their application for the original American patent it was argued on their behalf that 'their invention relates to a series or combination of processes, in the order in which they are stated, for treating shavings, &c.' The several processes and their order was then stated. An 'order and series of processes' is what, according to the statement made in support of their application, 'constituted their invention, and what they supposed they had embodied in their claim.' And the claim of the patent was for the treatment of wood shavings by chemical agencies '*in the order* substantially as described.' How, then, is it possible to maintain that a process to obtain pulp by chemical action in a single operation had been invented by the patentees when their

first patent was granted? And what is of more importance, how is it possible to hold that such an invention was patented to them? We find no satisfactory evidence that the idea of a single-stage process was ever conceived by Watt & Burgess until after a patent disclosing it was granted to Marie Amedee Charles Mellier on the 26th day of May, 1857. This was before the surrender of their original patent, and before the reissue. And if Watt & Burgess had not invented the single-stage process, when their original patent was granted, the reissue 1449 is for a different invention from that described or referred to in the original patent; and such is the testimony of the experts who have been examined in this case. But the testimony of the experts is not needed. It appears on the face of the reissue that it is for a different invention, for the reissue is attempted to be sustained only on the ground that it is for a single-stage process. Both the reissues, therefore, we think, are void." (598-599)

RUSSELL v. DODGE, 93 U. S. 460 [1876]

Interval—6 months

Motive of Reissue—To change specification and enlarge claim beyond limits of novelty.

Subject Matter—The original patent was for a process of treating bark-tanned lamb or sheep skins by a compound including heated fat liquor. The reissue was for the use of fat liquor in the treatment of leather generally, and whether hot or cold.

HELD

"It is clear from this statement that the patent [reissue] is for the use of fat liquor in any condition, hot or cold, in the treatment of leather, and for a process of treating

bark-tanned lamb or sheep skin, by means of a compound in which fat liquor is the principal ingredient. The state of the liquor is not mentioned as essential to the treatment, or to accomplish any of the results sought. It is only stated as a thing to be desired, that the liquor should be heated, and that it would be preferable that other ingredients were mixed with the heated liquor to make the compound mentioned. In other words, the specification declares, that by heating the liquor the effect desired will be more readily produced; that is, more speedily or with less trouble and expense, not that the heating is in any respect essential to the treatment. Where a useful result is produced in any art, manufacture, or composition of matter by the use of certain means for which the inventor or discoverer obtains a patent, it is, as justly observed by the presiding justice of the Circuit Court, too plain for argument, that the means described must be the essential and absolutely necessary means, and not mere adjuncts which may be used or abandoned at pleasure.

The original patent was less extensive in its claim than the reissue. That patent was for a process of treating bark-tanned lamb or sheep skin by means of a compound, in which heated fat liquor was an essential ingredient. The specification was explicit in this particular, and left no doubt on the subject. The reissued patent covers the use of the fat liquor in any condition, hot or cold, and when used alone or in a compound with other ingredients, and thus has a more extended operation, bringing under it manufactures not originally contemplated by the patentee. Is such a reissue valid?" (462-3)

"A defective specification could be rendered more definite and certain so as to embrace the claim made, or the claim could be so modified as to correspond with the specification; but except under special circumstances, such as occurred in the case of *Lockwood* v. *Morey*, 8 Wall. 230,

where the inventor was induced to limit his claim by the mistake of the Commissioner of Patents, this was the extent to which the operation of the original patent could be changed by the reissue. The object of the law was to enable patentees to remedy accidental mistakes, and the law was perverted when any other end was secured by the reissue.

Judged by that law,—and the provisions of the act of 1870 on this subject are substantially the same,—there can be no doubt of the invalidity of the reissue. The original patent was not inoperative nor invalid from any defective or insufficient specification. The description given of the process claimed was, as stated by the patentee, full, clear, and exact, and the claim covered the specification; the one corresponded with the other. The change made in the old specification, by eliminating the necessity of using the fat liquor in a heated condition, and making in the new specification its use in that condition a mere matter of convenience, and the insertion of an independent claim for the use of fat liquor in the treatment of leather generally, operated to enlarge the character and scope of the invention. The evident object of the patentee in seeking a reissue was not to correct any defects in specification or claim, but to change both, and thus obtain, in fact, a patent for a different invention. This result the law, as we have seen, does not permit." (463-464)

"But, assuming that the reissue is not void for the reasons stated, the patent is still invalid for want of novelty in the alleged invention. The use of fat liquor in the treatment of bark-tanned skins was general with manufacturers for many years previous to the alleged invention." (465)

SMITH v. GOODYEAR DENTAL VULCANITE COMPANY,
93 U. S. 486 [1870]

Interval—8 months

Motive of Reissue—To enlarge the claim to dominate interim devices.

Subject Matter—Denture.

HELD

"A brief review of the history and nature of the patent which the complainants allege has been infringed will aid materially in solving the questions presented by this appeal." (489)

"It is further insisted by the defendant that the reissued patent on which this suit is founded is not a patent for the same invention which was described in the specification of the original patent, and, therefore, that the reissue is unauthorized and void. To sustain this position the defendant must overcome the presumption against him arising from the decision of the Commissioner of Patents in granting the issue; and this he can do only by showing, from a comparison of the original specification with that of the reissue, that the former does not substantially describe what is described and claimed in the latter. This must plainly appear before we can be justified in pronouncing the reissued patent void. But this, in our judgment, does not appear. The first specification describes a set of artificial teeth having a hard-rubber plate made by a process substantially the same as that indicated in the later patent. The description of the process is not quite so minute; but it is sufficiently full to be understood, and to enable an operator to make the manufacture. Certainly it is not another process; and as its result is the same, it is impossible to hold that the reissued patent is for a different invention from the one protected by the original patent." (499-500)

KEYSTONE BRIDGE CO. v. PHOENIX IRON CO.,
95 U. S. 274 [1877]

Subject Matter—This was a decision on an original patent but, in passing on scope, the Court announced the rule that in a proper case a broadened reissue may be valid.

HELD

"Here, again, the patentees clearly confine themselves to *'wide and thin'* bars. They claim the use in truss bridges of such bars when the ends are upset and widened in the manner described. It is plain, therefore, that the defendant company, which does not make said bars at all, but round or cylindrical bars, does not infringe this claim of the patent. When a claim is so explicit, the courts cannot alter or enlarge it. If the patentees had not claimed the whole of their invention, and the omission has been the result of inadvertence, they should have sought to correct the error by a surrender of their patent and an application for a reissue." (278)

GLUE COMPANY v. UPTON, 97 U. S. 3 [1877]

Interval—6 years

Motive of Reissue—Not stated.

Subject Matter—The patent was held invalid for lack of patentable subject matter. The Court did not pass on the defenses of whether the reissue was for the same invention as the original; but it is indicated that the test of such question would be whether the reissue differed in any substantial particular.

HELD

"We shall treat the reissue as for the same invention or discovery, differing in no substantial particular from that originally patented." (4)

MARSH v. SEYMOUR, 97 U. S. 348 [1877]

Interval—10 years

Motive of Reissue—Not stated.

Subject Matter—Three reissues for reaping and harvesting machines were involved of which two had been passed on in *Seymour* v. *Osborne*, 78 U. S. 516. In order to pass on the defenses the Court first considered the rank of the inventions in view of the prior art.

HELD

"Patents, in a proper case, may be surrendered and reissued, but the reissued patent must be for the same invention as the original patent, else the reissue is invalid; but the patentee may redescribe his invention, and include in the description and claims of the specification not only what was well described before, but whatever else was suggested or substantially indicated in the old specification, drawings, or patent-office model, which properly belonged to the invention as actually made and perfected. Corrections may be made in the description, specification, or claims of the patent where the patentee has claimed as new more than he had a right to claim, or where the description, specification, or claim is defective or insufficient; but he cannot, under such an application, make material additions to the invention which were not described, suggested, nor substantially indicated in the original specifications, drawings, or patent-office model." (355-356)

RAILWAY CO. v. SAYLES, 97 U. S. 554 [1878]

Subject Matter—This was a decision on an original patent which, however, had been substantially modified before issuance. The Court held non-infringement, but re-

ferred to the analogy between amendments to an original application and the amendments of original patents by reissue.

HELD

"* * * if the amended application and model, filed by Tanner five years later, embodied any material addition to or variance from the original,—anything new that was not comprised in that,—such addition or variance cannot be sustained on the original application. The law does not permit such enlargements of an original specification, which would interfere with other inventors who have entered the field in the meantime, any more than it does in the case of reissues of patents previously granted. Courts should regard with jealousy and disfavor any attempts to enlarge the scope of an application once filed, or of a patent once granted, the effect of which would be to enable the patentee to appropriate other inventions made prior to such alteration, or to appropriate that which has, in the meantime, gone into public use." (563-564)

HYNDMAN v. ROOTS, 97 U. S. 224 [1877]

Interval—11 months

Motive of Reissue—Not stated.

Subject Matter—Structure of Rotary Blowers.

HELD

"The answer denies * * * that the reissue is for the same thing as the original patent; * * *

Such were the issues made by the appellant in the court below. That Court found all of them in favor of the appellees, and decreed accordingly. * * * The questions are questions of fact. No legal proposition is involved." (226-27)

BATES v. COE, 98 U. S. 31 [1878]

Interval—4 years

Motive of Reissue—Not stated.

Subject Matter—Drilling and bolt-tapping machine.

HELD

"In determining about similarities and differences, courts of justice are not governed merely by the names of things; but they look at the machines and their devices in the light of what they do, or what office or function they perform, and how they perform it, and find that a thing is substantially the same as another, if it performs substantially the same function or office in substantially the same way to obtain substantially the same result; and that devices are substantially different when they perform different duties in a substantially different way, or produce substantially a different result." (42)

POWDER COMPANY v. POWDER WORKS, 98 U. S. 126 [1878]

Interval—7 years

Motive of Reissue—Not stated.

Subject Matter—The original was for a process of exploding nitro-glycerine. The reissues were for mixtures and compositions.

HELD

"If it were a case in which the identity or non-identity of the inventions in the original and reissued patents was a complicated question, the court might require the defendants to answer, in order to have the benefit of evidence on the subject." (134)

"Now, in all this specification there is not a hint of any new mixture or new composition of matter having been invented by the patentee." (135)

"Inasmuch as the reissued patents in question, numbered 4818 and 4819, are for compounds of nitro-glycerine with various other substances, it is impossible not to say that they are for an entirely different invention from that secured, or attempted to be secured, by the original patent. If the patent had been not for the mode or process of exploding nitro-glycerine, but for the process of compounding nitro-glycerine with gunpowder and other substances, inadvertently omitting to claim the exclusive use of the substances so produced, the case would have been one of very different consideration. That was the case with Goodyear's patent, which was issued in 1844, and claimed only the process of vulcanizing india rubber. In 1849 it was surrendered, and two new patents issued in lieu thereof,—one for the process, and the other for the composition. In 1852, the validity of these reissues came up for consideration in the third circuit, in the case of *Goodyear* v. *Day*, which was argued by Mr. Choate, Mr. Webster, and other eminent counsel. Mr. Justice Grier disposed of the objections as follows: 'We now come to the objections which have been made to the reissued or amended patents of 1849. The first objection is that the patents of 1844 and 1849 are not for the same invention. This objection is not founded in fact. Both patents are for precisely the same invention or discovery. They both describe, in nearly the same words, the best mode of manufacturing india-rubber, by exposing it to a high degree of heat in connection with sulphur and white lead; by which treatment the substance is endowed with new and valuable qualities which it did not possess before. The discovery is the same; the mode of manufacturing the compound is the same. The first patent had set forth the nature and extent of the invention defec-

tively. There is no reason to doubt the *bona fides* and propriety of the reissue. It is apparent on the face of the papers, even if the action of the commissioner on that point was not conclusive.' Again, he adds: 'The fourth objection is 'that the latter patent claims more than was contained in the original.' If the latter patent is for precisely the same invention, art, or discovery as that described in the first, the objection that it claims more is a mistake of fact. If the last patent differs from the first only in stating more clearly and definitely the real principles of the invention, so that those who wish to pirate it may not be allowed to escape with impunity through the imperfection of the language used in the first, there has arisen one of the cases for which it was the intention of the act of Congress to provide, and the objection is worthless in point of law.' This case is partially reported in 2 Wall. Jr. 283, but the opinion of Mr. Justice Grier is not stated in full." (136-137)

"The present case is entirely different. The processes which the patentee described as his invention in the original patent, No. 50,617, had no connection with the compounds or mixtures which are patented in the reissued patents. They were not processes for making those compounds, and in describing them the compounds were not mentioned. The invention of the one did not involve the invention of the other. The two inventions might have been made by different persons, and at different times.

We think, therefore, that the conclusion is irresistible, that the two reissued patents, numbered 4818 and 4819, are for a different invention from that described or suggested in the original patent No. 50,617, upon which they are founded, and which they are intended, in part, to supersede." (137)

"The specification may be amended so as to make it more clear and distinct; the claim may be modified so as to make

it more conformable to the exact rights of the patentee; but the invention must be the same. So particular is the law on this subject, that it is declared that 'no new matter shall be introduced into the specification'. This prohibition is general, relating to all patents; and by 'new matter' we suppose to be meant new substantive matter, such as would have the effect of changing the invention, or of introducing what might be the subject of another application for a patent. The danger to be provided against was the temptation to amend a patent so as to cover improvements which might have come into use, or might have been invented by others, after its issue." (138)

"It does not authorize him to grant a reissue for a different invention, or to determine that one invention is the same as another and different one; or that two inventions essentially distinct constitute but one." (138-139)

WATER-METER COMPANY v. DESPER, 101 U. S. 332 [1879]

Interval—4 years

Motive of Reissue—To enlarge claim to dominate interim device.

Subject Matter—The original patent covered a combination of particular elements making up a water meter having two parallel cylinders each traversed by two connected pistons, a shaft with a crank at each end extended from one piston rod to the other. The defendant's water meter omitted the shaft with its two cranks, pinion and gearing.

HELD

"The meter manufactured by the defendants is different in several respects from that described in the complainant's patent. It has a rotary valve like the latter, but

without any bevel-gear; it also has two cylinders, with an immaterial difference of position, being placed at right angles with each other instead of being parallel; each cylinder is likewise provided with two double-acting pistons, connected by a piston-rod, the same as in the complainant's meter; the cylinder-heads are also furnished with Ericsson's stops projecting inside for arresting the movement of the pistons, though these stops are fixed and not adjustable. But the meter of the defendant's has no crank-shaft, and no semblance of a crank-shaft, for imparting motion from the pistons to the rotary valve; on the contrary, their valve is connected directly with the piston-rods in the following manner: The piston-rods cross each other at right angles, having transverse slots, and being halved together, one lying immediately on the other, so that the axes of the pistons are in the same plane. The valve below is connected directly with the piston-rods by a single crank which is keyed on to its upper solid stem, and has a crank-pin which works in the two slots of the respective piston-rods. Thus arranged, the successive reciprocating movements of the two double pistons impart a circular motion to the valve, which, by duly arranged induction and eduction ports, alternately fills and empties the respective cylinders.

From this it appears that, in the construction of defendants' meter, the crank-shaft, with its two cranks, pinion, and gearing connection (which is an essential feature of the complainant's meter), is altogether dispensed with. The defendants effect the desired result of communicating rotary motion to the valve without any such shaft, or any thing equivalent thereto. The entire part, with all its appurtenances, is thrown out of their machine. They use a crank, it is true; but it is attached directly to the rotary valve, and is a part of it. The use of a crank in converting reciprocating into rotary motion is an old device. It was applied to the steam-engine a century ago, and has been

applied to hundreds of different machines since that time. Ball and Fitts had no claim to it, but only to the particular method and device by which they employed it, in combination with the various other parts of their meter. Instead of the crank-shaft, had they in their patented combination claimed every method, and all methods, of communicating motion from the piston-rods to the rotary valve by means of a crank, the defendants' meter would have been an infringement. But such a claim might not have been valid. At all events, it was not allowed.

The specification was evidently drawn with great care, and it is to be presumed that the patentees claimed all that the Patent Office considered them entitled to. We cannot say that the crank-shaft was an immaterial part of their combination. The patent, as it stands, occupies very narrow ground. It requires the presence of every one of the elements specified in the combination secured by it. We think that the defendants do not use all of these elements, but that they dispense with one of them at least which is material in the complainant's meter. Our conclusion, therefore, is, that they do not infringe the complainant's patent." (335-337)

BALL v. LANGLES, 102 U. S. 128 [1880]

Interval—13 years

Motive of Reissue—To change disclosure and claim to cover interim devices.

Subject Matter—The original was for a cooking oven constructed so that the combustion products could not be passed through it.

HELD

"The commissioner was invested with authority to determine whether the surrendered patent was valid by reason

of a defective or insufficient specification, or because the patentee had claimed more than he had a right to claim as new; and if he found such to be the case, and found also that the error had been due to inadvertence, accident, or mistake, without fraud, his decision was conclusive, and not subject to review by the courts. But the law did not confer upon him jurisdiction to grant a reissue embracing new matter, or a broader invention than what was revealed by the original specification, or drawings or models, except in some cases where there was neither model nor drawing. A reissue for anything more is, therefore, inoperative and void. Accordingly, this court has repeatedly held that if, on comparing a reissue with its original, the former appears on its face to be for a different invention from that described or indicated in the latter, it must be declared invalid." (129-130)

"If, now, we turn to the reissues of 1869 and 1870, it cannot be doubted that while they claim what was claimed in the original, they claim much more. They claim an entirely different mode of heating the chamber, necessitating a radical difference in the construction of the oven.

The specification of the reissue of 1870, as well as that of 1869, instead of representing the space above the fire-chamber as communicating with the interior chamber only indirectly through perforations in the vertical and back flues, described it as communicating 'directly or indirectly in any proper manner with the chamber in which the bread-receiving shelves or platforms are revolved.'" (131)

"Thus his reissued patent has become one for an oven in which there may be no diaphragm or partition separating the compartment in which the dough is placed from the furnace by which it is heated, and which may be directly under it. Thus the oven is made a part of the passageway for the products of combustion from the fire-chamber to the chimney. That this is a very different invention from

anything exhibited in the original specification and drawings is too obvious to need further elucidation. We cannot doubt that the purpose of the reissues was not to cure defects in the original specification, or any deficiency in describing the invention, but to cover other devices which the patentee had not in mind when he first applied for his patent, and which may have subsequently come to his knowledge. Thirteen years after the patent was granted had elapsed before he applied for any reissue. However this may be, the reissued letters are so clearly for a different invention from that for which the patentee first applied, containing new matter, and so much broader, that we are constrained to hold that the Commissioner of Patents had no authority to grant them, and consequently that they are void." (132)

GARNEAU v. DOZIER, 102 U. S. 230 [1880]

Interval—15 years

Motive of Reissue—To cover materially efficient interim device.

Subject Matter—The reissue patent held invalid in *Ball* v. *Langles*, 102 U. S. 128, was again in issue and the ruling of invalidity adhered to. Another reissue patent was also involved, which was held non-infringed.

HELD

"To determine accurately the extent of the invention secured by this patent, the state of the art at the time when the original patent was granted (May 1, 1860) must be considered. Before that time, ovens were well known, and they had been constructed with a baking-chamber, a fireplace or furnace (one or more) arranged immediately under the chamber, and with a rotating reel located within

the chamber, and revolving around a horizontal shaft, the reel provided with gravitating shelves or pans suspended on rods attached to its arms. Some of these ovens were arranged so that a portion of the heated products of combustion should pass into and through the baking-chamber, though indirectly by a circuitous route." (234)

"It is obvious, therefore, that if the McKenzie patent can be sustained at all, it must receive a very limited construction." (234)

MANUFACTURING COMPANY v. LADD, 102 U. S. 408 [1880]

Interval—12 years

Motive of Reissue—To enlarge for dominating interim devices.

Subject Matter—The original patent was for a water wheel of specific construction and form with its associated apparatus.

HELD

"It was conceded that if the reissued patent should be construed literally, without restraining the generality of its claims by a reference to the original patent, the wheels made by the defendant would be an infringement; but the court, in view of the state of the art at the date of Swain's invention, and of the distinct limitation of that invention in the original patent to a wheel of specific construction and form, considered itself bound to construe the claims of the reissued patent in accordance with such limitation, in order to avoid the conclusion that it was for another and different invention from that originally patented. From a careful examination of the evidence in the case we are satisfied that this was the most favorable view that could have been

taken for the complainant. A comparison of the original letters-patent, including the drawings and model, with the reissued patent, makes it very evident that the latter is the result of an effort to enlarge the scope of the patent so as to include and embrace within it matters and things that were not embraced in the original invention. The original specification, drawings, and model all agree in describing a specific wheel and associated apparatus as the subject of the invention secured by the letters-patent." (409-410)

"But a change comes over the scene: the patent becomes the property of a corporation that manufactures wheels; a monopoly of the business is very desirable; other manufacturers make turbine wheels approaching somewhat in appearance to that described in Swain's patent. The usual remedy in such cases is resorted to. A reissue of the patent is sought, with expanded claims, sufficiently general and comprehensive to embrace a wide monopoly of structure, and to shut up competing establishments." (411)

"In a clear case of mistake—not error in judgment—the patent may undoubtedly be enlarged; but that should be the exception, not the rule; whereas the enlargement of claims has become the rule, and their contraction the exception." (411)

"The patentee desires to secure the monopoly of every centrevent wheel, of whatever shape or form, which discharges the water both inwardly in the centre of the wheel and downwardly from the bottoms of the floats beneath the wheel. But that would be a new invention, very different from what was described and claimed in the original patent. To warrant this extension of the claim, the specification of the reissued patent contains material variations from that of the original, frequently stating that a particular part *may* be constructed thus and so, when the original *required* it to be thus and so; it speaks of "the upper hori-

zontal edge of the floats," when no such thing is mentioned in the original, but on the contrary the rim over the floats was described as curving inward and downward, and as being so curved for a special purpose and effect. Instead of correcting inadvertent mistakes in the specification, which rendered the patent inoperative and void, the pretended corrections are evidently intended to widen the scope of the patent, and to make it embrace more than it did at first. So far as description went, the original specification was as perfect as the new one." (412-413)

"If the appellant insists on the broad construction of the claims in the new patent, it must take the risk of being met with previous achievements in the same line of improvement, which may very seriously endanger the validity of its patent. Several structures have been produced on the hearing, antedating the invention of Swain, and it would be very difficult to maintain that they do not embrace the principal feature in Swain's wheel, sought to be appropriated by him." (414)

MANUFACTURING COMPANY v. CORBIN, 103 U. S. 786 [1880]

Interval—6 years

Motive of Reissue—To change materially the claimed device.

Subject Matter—The original patent was for a window sash lock and narrowly claimed a combination of six elements. The reissue broadly claimed a combination of three elements, which was not the invention of the joint inventors, but of one of them solely for which he had earlier and separately applied for a patent which was refused for lack of novelty.

HELD

"The essential distinction between the original invention of Voll, for which letters were refused, and that covered by the reissue to the appellant, is this: In the contrivance first named the locking lever when in locked position was held fast in its place by a bolt which was driven by a spiral spring into a hole in the stump on which the lever was pivoted. In the contrivance covered by the letters to Voll and McGregor the bolt which holds the locking lever in its place, instead of entering a hole in the post, is forced by the spiral spring past the end of a segment raised upon a base plate, which prevents a sidewise movement of the locking lever until the bolt is retracted.

The sash lock manufactured by appellees, which appellant alleged was an infringement of its reissued letters, had placed on the end of the locking lever a pivoted latch provided with a downward projection, which, when the locking lever was placed in a locking position, entered a hole or socket in the base plate.

The court below dismissed the bill. Its decree is brought here for review.

The defence insisted on is that if the claim of the appellant's reissued letters be construed to cover the appellees' sash locks, it is void, because it embraces the previous invention made by Voll alone, which had been abandoned to the public after it had been rejected by the Patent Office, and which was not the invention of Voll and McGregor jointly, and that if the reissue is so construed as to cover the sash locks made by the appellees, it is for a different invention from that which the original letters to Voll and McGregor covered." (789-790)

"Conclusive evidence to establish the defence is found in the amendments made by the appellant in its application for reissue. If the reissue had been granted as applied for, it might with some plausibility have been claimed that the

reissued letters were infringed by the sash locks made by the appellees. But the application in its original form was not granted. The specification for the reissue was amended by striking out, wherever they occurred, the words 'socket or depression in the base plate,' and substituting the words 'catch segment or segment.'

This shows beyond controversy that in asking for a reissue the appellant sought to make its letters cover sash locks like those made by the appellees, but was not able to do so, and the reissue was restricted to a sash lock in which the locking lever was made fast by a bolt driven past the end of a segment raised on the base plate." (791)

MILLER v. BRASS CO., 104 U. S. 350 [1881]

Interval—16 years

Motive of Reissue—To broaden dominate interim devices.

Subject Matter—The patent was for a kerosene lamp burner and claimed a combination of devices including two reflectors elevated above a perforated cap enclosing a wick tube and dispensed with the need of a chimney.

HELD

"The invention proved a failure, but it was found that the use of one of the domes (and the other parts), with the restoration of the chimney, would be a real improvement, and both the complainant and the defendant made such lamps in large quantities. Fifteen years after the original patent was granted, the patentee (or rather his assignee) discovers that the improved lamp was really a part of his original invention, and that by inadvertence and mistake he had omitted to claim it. We think, however, that the court below was clearly right in holding that the invention specified in the second claim of the reissued

patent (which is the one in question here) is not the same invention which was described and claimed in the original patent. The latter was for a double dome without a chimney, the peculiarity of the supposed invention being the use of the double dome as a means of dispensing with the chimney. The reissue is for a single dome with a chimney. It is not only obviously a different thing, but it is the very thing which the patentee professed to avoid and dispense with.

But there is another grave objection to the validity of the reissued patent in this case. It is manifest on the face of the patent, when compared with the original, that the suggestion of inadvertence and mistake in the specification was a mere pretense; or if not a pretense, the mistake was so obvious as to be instantly discernible on opening the letters-patent, and the right to have it corrected was abandoned and lost by unreasonable delay. The only mistake suggested is, that the claim was not as broad as it might have been. This mistake, if it was a mistake, was apparent upon the first inspection of the patent, and if any correction was desired, it should have been applied for immediately.

These afterthoughts, developed by the subsequent course of improvement, and intended, by an expansion of claims, to sweep into one net all the appliances necessary to monopolize a profitable manufacture, are obnoxious to grave animadversion. The pretense in this case that there was an inadvertence and oversight which had escaped the notice of the patentee for fifteen years is too bald for human credence. He simply appealed from the judgment of the office in 1860 to its judgment in 1876; from the commissioner and examiners of that date, to the commissioner and examiners of this; and upon a matter that was obvious on the first inspection of the patent. If a patentee who has no corrections to suggest in his specification except to make his claim broader and more comprehensive, uses due diligence in returning to the Patent Office, and says, 'I omitted

this,' or 'my solicitor did not understand that,' his application may be entertained, and, on a proper showing, correction may be made." (351-352)

"At all events, we think it clear that it was not the special purpose of the legislation on this subject to authorize the surrender of patents for the purpose of reissuing them with broader and more comprehensive claims, although, under the general terms of the law, such a reissue may be made where it clearly appears that an actual mistake has inadvertently been made. But by a curious misapplication of the law it has come to be principally resorted to for the purpose of enlarging and expanding patent claims. And the evils which have grown from the practice have assumed large proportions. Patents have been so expanded and idealized, years after their first issue, that hundreds and thousands of mechanics and manufacturers, who had just reason to suppose that the field of action was open, have been obliged to discontinue their employments, or to pay an enormous tax for continuing them.

Now whilst, as before stated, we do not deny that a claim may be enlarged in a reissued patent, we are of opinion that this can only be done when an actual mistake has occurred; not from a mere error of judgment (for that may be rectified by appeal), but a real *bona fide* mistake, inadvertently committed; such as a Court of Chancery, in cases within its ordinary jurisdiction, would correct. Reissues for the enlargement of claims should be the exception and not the rule." (354-355)

JAMES v. CAMPBELL, 104 U. S. 356 [1881]

Interval—7 years

Motive of Reissue—To broaden to cover interim device.

Subject Matter—The original patent dealt with a postage cancelling stamp and narrowly claimed a particular

structure of a post marking stamp and cancelling stamp. The reissue claimed the broad cancelling stamp alone and the broad cancelling stamp with any post marking stamp.

HELD.

"The government of the United States, as well as the citizen, is subject to the Constitution; and when it grants a patent the grantee is entitled to it as a matter of right, and does not receive it, as was originally supposed to be the case in England, as a matter of grace and favor." (358)

"It will be seen that the invention claimed is very specific and definite in its character." (361)

"It is plain, therefore, that elasticity in the material of which the blotter was to be composed was a distinctive feature of the blotting device thus separately claimed." (362)

"It was not without good cause, therefore, that the separate claim for the cancelling device, as a distinct invention, was confined to an elastic type or blotter enclosed in a hollow tube." (362)

"The evidence does not show to our satisfaction that Norton was by any means the first inventor of a double post-office stamp, so constructed as to make the post-mark and cancel the postage-stamp at one blow." (363)

"Now, there is abundant evidence in the record to show that double stamps were conceived of and used before 1859, and that about that time they sprung up spontaneously in various parts of the country." (367)

"No one can read the patent in the light of these contemporary documents, and of the previous history of the stamp,

without arriving at the conclusion that, so far as the blotting device was separately concerned, the invention consisted of, and was confined to, a tube containing a type-blotter made of an elastic substance, as contradistinguished from iron or other hard substance. The iron or steel blotter had been patented in 1862, as already mentioned, and as will be shown more fully hereafter. There was not, there could not have been, any inadvertence or mistake in confining the invention to the combination described and claimed in the patent." (369-370)

"Of course, if, by actual inadvertence, accident, or mistake, innocently committed, the claim does not fully assert or define the patentee's right in the invention specified in the patent, a speedy application for its correction, before adverse rights have accrued, may be granted, as we have explained in the recent case of *Miller* v. *Brass Company*, *supra*, p. 350. But where it is apparent on the face of the patent, or by contemporary records, that no such inadvertence, accident, or mistake, as claimed in a reissue of it, could have occurred, an expansion of the claim cannot be allowed or sustained." (371)

"By these extracts from the specification, and the summary of claims, it appears perfectly obvious that the patentee has embraced in the reissued patent several matters of supposed invention different from and additional to the invention which formed the subject of the original patent. And it is principally, if not wholly, these new and additional claims which the appellant James, as postmaster of New York, is charged with infringing.

In the first place, a new form of the cancelling device is set forth and claimed, different from that described in the original patent, to wit, a cancelling type or die attached directly to the cross-bar, without any tube or pipe surrounding and holding the same. This is not contemplated or hinted at in the original patent." (374)

"Not a hint was given that the cylinder could be dispensed with. This was an after-thought. The cylinder was clearly and distinctly set forth as a necessary constituent of the device, and an essential element in the combination of which the blotting device consisted.

The bearing which this new feature in the reissued patent has on the case is evinced by the fact that one of the devices used for several years in the post-office, which is complained of as an infringement of the patent, was a naked blotter made of cork, directly attached to the cross-bar, without any enclosing cylinder to support it; also by the fact that the other device used in the post-office during the defendant's term of office consisted of an iron blotter directly attached to the side of the postmarking stamp without any enclosing cylinder.

In our judgment this addition to the patent was no part of the original invention, and could not lawfully be embraced in the reissue, and that the claim for it is therefore void." (375)

"This language amounts to an express disclaimer of solid metal." (376)

"How, after this, it could be supposed that the use of solid metal as a material for the type-blotter was included in the invention, and that a claim for it was omitted through inadvertence and mistake, it is difficult to understand." (376)

HEALD v. RICE, 104 U. S. 737 [1881]

Interval—1 year, 5 months

Motive of Reissue—To broaden and cover new matter.

Subject Matter—The patents related to a straw burning furnace comprising a return-flue boiler. The reissue was for the combination of another inventor's straw feeding device with the boiler.

HELD

"In the present case the question of the identity of the invention in the original and reissued patents is to be determined from their face by mere comparison, notwithstanding what was said in *Battin* v. *Taggert* (17 How. 74), and consistently with *Bischoff* v. *Wethered* (9 Wall. 812), according to the rule laid down in *Seymour* v. *Osborne* (11 Wall. 516), and *Powder Company* v. *Powder Works, supra.* That is, if it appears from the face of the instruments that extrinsic evidence is not needed to explain terms of art, or to apply the descriptions to the subject-matter, so that the court is able from mere comparison to say what is the invention described in each, and to affirm from such mere comparison that the inventions are not the same, but different, then the question of identity is one of pure construction, and not of evidence, and consequently is matter of law for the court, without any auxiliary matter of fact to be passed upon by a jury, if the action be at law." (749)

"It appears, then, from the mere reading of the two specifications, that the invention described in the first is for the return-flue boiler; while that described in the second, abandoning the claim for the boiler itself, is for a particular mode of using it, with straw as a fuel, by means of an attachment to the furnace-door for that purpose. It might well be that Rice was entitled to patents for both, separately, or to one for both inventions. But it is too plain for argument that they are perfectly distinct. A patent, consequently, originally issued for one cannot lawfully be surrendered as the basis for a reissue for the other." (753)

"The second principal objection to the validity of the Rice reissued patent is, that it is anticipated by the Morey patents. We are of opinion that it also is well taken." (753)

MATHEWS v. MACHINE COMPANY, 105 U. S. 54 [1881]

Interval—14 years

Motive of Reissue—To cover wide departure in structure from original invention.

Subject Matter—The original patent was for a construction of a fire hydrant with the surrounding connected casing. The reissue changed the disclosure of the casing and altered its function. The reissue was condemned on account of the 14 years' delay and also on account of divergence of invention.

HELD

"There is still another objection to the claims in question. There is a wide departure from the original invention in this, that the subject of the latter was a jacket, or casing, whose top was enclosed and covered by a flange projecting from the hydrant, which effectually prevented the removal of the jacket without removing the hydrant also; and which caused the hydrant to be raised when the jacket was lifted by the frost. In the reissued patent nothing is said of this arrangement of the top of the jacket, and the claims ignore it altogether; so that, as already intimated, the patent as it now stands would cover such a jacket as that described and claimed in the complainants' patent of 1869, which slides like a sleeve over the hydrant at top as well as bottom. The reissue is not only for a broader claim made many years after the original was granted, but is for a different invention. Therefore, so far as the jacket is concerned, we think it cannot be sustained." (58)

BANTZ v. FRANTZ, 105 U. S. 160 [1881]

Interval—14 years

Motive of Reissue—To claim separately elements originally claimed as combination.

Subject Matter—The original narrowly claimed a combination of eight elements in a wet fuel furnace. The reissue claimed several of the parts separately.

HELD

"It is evident, therefore, that if the appellant had, in his application for the original patent, claimed as his own invention all the distinct devices described in the specification, he could not have obtained his patent in its present form. It could have been only on the ground that his claim was for a combination that it was allowed and the patent issued." (165)

"In this case the original patent bears date June 22, 1858. The reissue bears date Feb. 6, 1872, more than thirteen years and six months after the date, and less than five months before the expiration, of the original patent. If the specification in the original patent was defective or insufficient in claiming a combination of several devices instead of making a distinct claim for every device which entered into the combination, the fact was instantly discernible, even to an unpractised eye, as soon as the patent was read. Therefore, as said by Mr. Justice Bradley in delivering the opinion of this court in a similar case, *Miller v. Brass Company* (104 U. S. 350), if any correction was desired it should have been applied for immediately; the right to have the correction made was abandoned and lost by unreasonable delay. That case is apposite and is conclusive of this." (165-166)

JOHNSON v. RAILROAD CO., 105 U. S. 539 [1881]

Interval—15 years

Motive of Reissue—To enlarge the claim to dominate interim device.

Subject Matter—The original patent showed and claimed a self-adjusting fastener for attaching metal roofs to buildings. The reissue broadly claimed a sub-combination used in connecting railway rails together.

HELD

"It takes but slight comparison of the patents to show that this contention is well founded. The original patent was for a complicated contrivance, consisting of a number of old devices combined, and specially adapted to the fastening of metallic coverings to buildings, and for use in all other places where metals require fastening and their contraction and expansion require accommodation. To make the invention of any practical value for the purpose suggested in the specification, and for use in the 'other places' referred to, all the parts of the device therein described, except, perhaps, the rubber cord, which is only for temporary use in applying the device, are absolutely essential. Nowhere in the specification is it indicated or suggested that any part of the device described can be dispensed with. It is perfectly clear that the stud and bottom-plate of the contrivance are absolutely necessary to the only specific use mentioned in the specification. If these are left out there is no connection between the two materials to be fastened together; namely, the metal roof and the wooden sheathing under it. As the declared purpose of the invention is the fastening of these two materials together, it is difficult to see how the parts of the device essential to the fastening can be discarded, and the invention still remain perfect and unchanged." (545-546)

"Under the original patent the materials or things to be fastened together are the metallic covering of the roof and the under surface of the wooden sheathing on which it is laid. The slotted plates or flanges are fastened to the under side of the sheathing by the bottom-plate, which connects the flanges, and they form a support for the adjusting-bolt; but the slotted flanges do not embrace or clamp any part of the wooden sheathing or any part of the metallic covering of the roof, much less do they embrace or clamp at the same time the sheathing and the metallic covering, which are the things to be fastened together. But in the reissued patent the slotted plates not only furnish bearings for the bolt, but perform a new and essential function, of furnishing a strong lateral support to the materials to be fastened together by clamping the same between them.

We find, therefore, that in the reissued patent several of the devices essential to the combination described in the original patent are left out and a separate claim made for the parts which remain, and to these parts a new and essential function is given, which they could not perform under the original patent.

It is, therefore, perfectly clear that the second claim of the reissued patent was not covered by the original patent. It describes another device operating in a different way and for a different purpose." (546-547)

"There was no error in the original patent caused by inadvertence, accident, or mistake, which could have escaped the notice of the patentee and his associates for fifteen years. It is not open to dispute that the fish-plate joint, precisely such as the appellants claim is covered by their reissued patent, was in general use during nearly the entire life of the original patent. Why did not the patentee earlier discover that all this use of the fish-plate joint was really an infringement on his patent and apply for a reissue and assert his rights? He has rested supinely until the use of the fish-plate joint has become universal, and then, after

a lapse of fifteen years, has attempted by a reissue to extend his patent to cover it. We think it is perfectly clear that the original patent could not be fairly construed to embrace the device used by the appellee, which appellants insist is covered by their reissue. If the reissued patent covers it, it is broader than the original, and is, therefore, void. *Giant Powder Co. v. Cal. Vigorit Powder Co.*, 6 Sawyer, 508; *Powder Company v. Powder Works*, 98 U. S. 126; *Ball v. Langles*, 102 id. 128; *James v. Campbell*, 104 id. 356.

Even if the patentee had the right to a reissue if applied for in seasonable time, he has lost it by his laches and unreasonable delay. *Miller v. Brass Company*, id. 350.

The defense of want of novelty set up in the answer is, in our opinion, also sustained by the evidence." (547)

GOSLING v. ROBERTS, 106 U. S. 39 [1882]

Interval—6 years

Motive of Reissue—To enlarge disclosure and claim to dominate interim device.

Subject Matter—The original patent was for a flexible plate connected at the top to a carriage door and at the bottom to the carriage step. The reissue made at least six recited changes in the original disclosure to arrive at a claim for a plate not held at its bottom to the step. Any scope of the reissue claim to cover defendant's device also made it invalid for lack of novelty.

HELD

"Accordingly, the reissue makes the statement, not found in the original, that the important feature of the invention is to have the plate attached to the door, and thus operate as a step-cover and a wheel-fender. The first claim of the

reissue is not found in the original, and grows out of the changes above mentioned. It is a broad claim to a combination with the step and the door of the plate E attached to the door, to operate as a step-cover and a wheel-fender, substantially as and for the purpose specified." (45)

"There is no difference in principle or mode of operation between the old structures and the defendant's structure. The difference is merely in form and shape. The plaintiff departed, in his original patent, from the principle of the old structures by joining his step-cover to the step and having the vertical plate yielding and flexible, so that its elasticity may keep the door open or closed. This, so far as appears, was a new invention, and he was entitled to claim it. He did claim it, and the original patent was adequate to secure it to him. The first claim of the reissue, if construed so as to cover the defendant's structure, must equally cover the old structures referred to." (46)

WING v. ANTHONY, 106 U. S. 142 [1882]

Interval—5 years

Motive of Reissue—To enlarge disclosure and claim to change invention from a particular plate holder and camera to a broad method of carrying on a process.

Subject Matter—Photographic apparatus or process.

HELD

"It is manifest that the reissued patent was taken out for the purpose of embracing under its monopoly what was not included by the original patent. The original patent was not, in the language of the statute, 'inoperative or invalid by reason of a defective or insufficient specification, or by reason of the patentee claiming as his own invention or discovery more than he had a right to claim as new.'

The original claim was for a mechanism; namely, 'a plateholder in combination with the frame in which it moves, constructed and operating in the manner and for the purpose' set forth in the specification. The claim of the reissued patent is plainly for a process; namely, 'the bringing of the different portions of a single plate, or several smaller plates, successively into the field of the lens of the camera, substantially in the manner and for the purpose specified'.

This claim would cover any mechanism by which the different parts of the plate could be brought into the field of the lens. In fact, the specification of the reissued patent suggests a different contrivance; namely, the causing of the lens of the camera to be made adjustable in different positions with respect to the plate, while the plate remains stationary, so that different portions of the plate may be brought into the field of the lens.

It is quite clear that the original patent covers a mechanism to accomplish a specific result, and that the reissued patent covers the process by which the result is attained, without regard to the mechanism used to accomplish it. The reissue is, therefore, much broader than the original patent, and covers every mechanism which can be contrived to carry on the process." (145-146)

"His device was simply a new and specific means to take advantage of a well-known law of nature. In his reissue, by claiming as his invention the process of bringing different parts of the plate successively into the field of the lens, he seeks to put himself in as good a position as if he had been the first to discover the law referred to, and the first to invent the method of taking advantage of the law by tilting his camera into different positions. In claiming the process he excludes all other mechanisms contrived to accomplish the same object. This he could not rightfully do." (146-147)

MOFFITT v. ROGERS, 106 U. S. 423 [1882]

Interval—2½ years

Motive of Reissue—To include device not originally shown and palpably not within description.

Subject Matter—The original patent was for an elongated shoe heel shaper mounted eccentrically upon a shaft. The reissue changed an essential respect.

HELD

"The original patent covered an elongated heel-shaped former, set eccentrically upon its shaft. This was an essential part of the invention described in the original patent." (426)

"The specification of the reissued patent omits both of these statements, and thus allows a 'former' to be made, if desired, with a circular cross-section, and to be set concentrically on its shaft. It is, therefore, clear that it covers a contrivance essentially different from that described in the original specification and claim." (427)

"The difference between the device covered by the specification and first claim of the original patent, and the device which might be embraced by the specification and first claim of the reissued patent, is essential and palpable." (427)

"The specification and first claim of the reissued patent are a plain attempt to include a device which was not and could not be fairly covered by the original patent. That claim is, therefore, for that reason void." (428)

HOFFHEINS v. RUSSELL, 107 U. S. 132 [1882]

Interval—4 years

Motive of Reissue—To alter description and enlarge claim.

Subject Matter—The patent dealt with a particular harvesting mechanism including a revolving rake.

HELD

"The original patent, No. 35,315, in stating what the invention is, says that it consists of certain improvements 'in the manner of mounting and operating a revolving rake.' There were three features set forth in the specification of No. 35,315: 1. The peculiar construction of the reel and rake. 2. The peculiar form and location of the rake-post. 3. The peculiar manner of operating the rakes. There were only three claims in No. 35,315, one covering each of said three features, * * *" (135)

"There is no warrant in the original patent for locating the rake-support, or any part of it, on the finger-beam." (138)

"The special kind of support described and shown in the patents, original and reissued, is essential to the operation of the special kind of raking apparatus there described. But the appellees' machine has a raking apparatus differently organized." (139-140)

"In analyzing the two machines, in view of the state of the art, it appears that the appellant adapted a continuously revolving gathering and discharging rake to a two-wheeled loosely jointed finger-bar machine. To do this he employed a peculiar rake and a peculiar rake-support. The appellees employ an entirely different rake. They have a

series of radial arms pivoted each independently of every other in a head, which has a double cam guideway for each arm, and the arms are thereby elevated vertically so as not to strike the frame in passing up. This makes it possible for the appellees to place the support for their rake on the finger-beam by the side of the frame and in the line of the cutters instead of behind the frame. No such organization is possible with the appellant's arrangement of rakes." (140)

"The appellees have not borrowed from the appellant. They devised a new arrangement of rake which made it possible for them to mount their rake-support on the heel of the finger-beam proper, where the appellant can never mount his and where that of the appellees is mounted. The theory of the reissue appears to be that, as the original patent shows a special device for supporting a special arrangement of rakes, such device being located on a particular part of the platform other than, and not possible to be, a part of the finger-beam, he can claim in a reissue any device for supporting a revolving rake, even one located on the finger-beam. To carry out this view, the word 'finger-beam' is interpolated in the specification, in this connection, as an addition to the word 'platform,' and the rake-post is described as being attached to the finger-beam *or* the platform. But there is an entire absence in the original specification, and in the reissued specification, of any description of any means by which the rake-support can be attached to or mounted on the finger-beam, or by which the rakes can be made to work with the rake-support in that location, or by which the connecting-rod of the cutters can be free to work with the support so placed. The law of reissues never at any time, or under any construction, allowed that to be done which has been thus attempted in this case." (141)

"The appellant's belt could not, in the same position, drive the raking apparatus so as to make it work properly. The appellees, by the use of sprocket-pulleys and a chain, dispense with a tight friction-band, and with a pulley around which the platform vibrates, and with a tightening pulley. Their arrangement is not an equivalent, in mechanism or functions, for that of the appellant." (142)

"The appellant's structure shows no such organization, and does not involve what the appellees have done." (143)

GAGE v. HERRING, 107 U. S. 640 [1882]

Interval—14 years

Motive of Reissue—To claim subject-matter materially different.

Subject Matter—The original narrowly claimed a particular new combination of seven old elements. The reissued claimed a sub-combination of three elements.

HELD

"No new device was invented by Denchfield, but his improvement consisted in a new combination of old means and devices. That combination, as described in the specification of his original patent, includes seven elements, * * *" (643)

"But the fan, with its communicating spout and meal chest, the dust room, the two conveyors, and the elevator, tend to one result, the cooling and drying of the meal, without waste or loss 'on its passage from the grinding stones to the bolts,' 'the whole,' as stated at the beginning of the specification, 'forming a simple and economical device;' and the single claim in the original patent is for

the arrangement and combination of the seven elements, designating them all with equal distinctness by appropriate letters.

The reissue was granted more than thirteen years and eight months after the date of the original patent, and less than four months before that patent would have expired; * * *" (644)

"The plaintiffs do not contend that in the original specification the patentee claimed as his own invention more than he had a right to claim as new; or that there is any defect or insufficiency in any part of the description or specification, other than the final claim. The descriptive part is, word for word, the same in the original and in the reissue. It is argued that the claim in the original patent was too much restricted by including in the combination elements which were no part of the real invention, and that this mistake might properly be corrected in the reissue. But there being no error in the descriptive part of the specification, any mistake in the claim, which is the more important part, and upon which other inventors and the public have the right to rely, as defining the limits of the invention patented, would be apparent on the face of the patent and could not escape the notice of any person reading it with the least care and attention." (645)

"To uphold such a claim, made so late, would be to disregard the principles governing reissued patents, stated upon great consideration by this court at the last term in the case of *Miller* v. *Brass Company*, 104 U. S. 350, and since affirmed in many other cases." (645)

DUFF v. STERLING PUMP COMPANY, 107 U. S. 636 [1882]

Interval—4½ years

Motive of Reissue—To claim subject-matter broader than actual novelty.

Subject Matter—The patent was for a wash-board having a rubbing surface of a particular shape. The reissue claim was broadened.

HELD

"The case is one where, in view of the state of the art, the invention must be restricted to the form shown and described by the patentee. In the field of wash-boards made of sheet metal, with the surface broken into protuberances formed of the body of the metal, so as to make a rasping surface, and to strengthen the metal by its form, and to provide channels for the water to run off, Todd was not a pioneer. He merely devised a new form to accomplish these results. *Railway Company v. Sayles*, 97 U. S. 554. The defendant adopts another form. Under such circumstances the Todd patent cannot be extended so as to embrace the defendant's form. The latter is not a mere colorable departure from the form of Todd, but is a substantial departure." (639)

CLEMENTS v. ODORLESS EXCAVATING APPARATUS CO., 109 U. S. 641 [1884]

Interval—5 years

Motive of Reissue—To enlarge claim to dominate interim device.

Subject Matter—The patent was for apparatus for cleaning vaults including a cask with a check valve controlling the inlet at the bottom and a flow valve con-

trolling the outlet at the top. The defendant's apparatus had no check valve and no substitute or equivalent.

HELD

"There is not in the specification of the original patent any suggestion or indication of any invention other than the two combinations severally claimed in the two claims. In the reissue there are material enlargements of the scope of the invention described and claimed in the original patent, and, apparently, with a studied view to include and cover, by descriptive words and by broader claims, an apparatus like that used by the defendant." (647)

"The original specification indicates nothing but a cask having the entrance opening in its bottom, furnished with a check-valve to open and shut such entrance automatically, the cask suspended vertically over the vault and lowered into it until the funnel at the bottom is sufficiently immersed, the filling of the cask in that position, and the raising it and emptying it. The cask in the defendant's apparatus has the entrance opening in its top, has no check-valve, is not suspended over or lowered into the vault, is placed at a distance from the vault, and is connected with the vault by a flexible pipe." (648)

"The effort was to obtain a reissue which should cover an apparatus having the cask located at a distance from the vault, with a flexible pipe from it to the vault, and a receiving opening in the top of the cask, and no check-valve—all of them features not indicated in the original patent, but all of them features existing in the Scharf patent granted after the original Bull patent and before the application for its reissue. The same observations apply to the patent to Frazier, No. 168,473, granted October 5th, 1875, more than three months before reissue No. 6,962 was applied for." (649)

"The expansions in claims 1 and 3 of the reissue were afterthoughts, developed by the subsequent course of improvement in the Schaff and Frazier patents, and intended to cover matters appearing in those patents and not claimed in the original patent, No. 115,565. No excuse is given for the delay in applying for the reissue, nor is any actual inadvertence, accident, or mistake shown." (649-650)

McMURRAY v. MALLORY, 111 U. S. 97 [1884]

Interval—9 years

Motive of Reissue—To broaden to cover interim device.

Subject Matter—The original was for a particular construction of soldering iron for can tops. The reissue did not alter the disclosure but enlarged the claims to cover an interim different construction. The difference between the original and reissue dealt with an essential element.

HELD

"The claim of the original patent was for a combination; that is to say, a combination of the disk A with the recess B on its under side, and the movable rod D to hold the lid of the can while resealing or closing. The specification mentioned a disk and particularly described and illustrated it as forming a part of the combination. By its size, shape, and the recess in its under surface, it was designed to perform certain specified functions. It was made thick so as to retain the heat; it was made circular, like the lid of the can, and of sufficient diameter to cover the lid, so as to reach its outer edge, where the soldering was to be done, and it had the recess in its under side sufficient to give room for the convexity of the lid so as to confine the soldering process to the outer edge of the lid.

The patent did not therefore include every soldering-iron of whatever form and shape." (102-103)

"In the reissue the first three claims of the Barker patent are expanded so as to include all soldering-irons, no matter what their shape or size, or specific advantages, in combination with the movable rod D. The contention of the appellants that a device so unlike the soldering-tool described in the original Barker patent as the Tillery & Ewalt tool is embraced by the first three claims of the reissue, is striking proof of the expansion of the original claim. It is plain that the claims mentioned include many soldering devices not covered by the original patent. The claims are therefore void." (103)

COCHRANE v. BADISCHE ANILIN & SODA FABRIK,
111 U. S. 293 [1884]

Interval—1½ years.

Motive of Reissue—To claim product dye however made, instead of one particular process.

Subject Matter—The original claimed a two-step process for making a chemical product alizarine. The reissue claimed the product, however made. The Court considered the prior art at length to evaluate the invention.

HELD

"It does not satisfactorily appear that the process of No. 4,321 will produce the defendants' article to any useful extent, if at all. The process of No. 4,321 never was, and is not now, practically carried on anywhere." (306)

"It is very plain that the specification of the original patent, No. 95,465, states the invention to be a process for preparing alizarine, not as a new substance prepared for

the first time, but as the substance already known as alizarine, to be prepared, however, by the new process, which process is to be the subject of the patent, and is the process of preparing the known product alizarine, from anthracine." (308-309)

"There is another view of the case. According to the description in No. 95,465, and in No. 4,321, and the evidence, the article produced by the process described was the alizarine of madder, having the chemical formula $C_{14}H_8O_4$. It was an old article. While a new process for producing it was patentable, the product itself could not be patented, even though it was a product made artificially for the first time, in contradistinction to being eliminated from the madder root. Calling it artificial alizarine did not make it a new composition of matter, and patentable as such, by reason of its having been prepared artificially for the first time from anthracine, if it was set forth as alizarine, a well known substance. *The Wood Paper Patent*, 23 How. 566, 593. There was, therefore, no foundation for reissue No. 4,321, for the product, because, on the description given, no patent for the product could have been taken out originally.

Still further, the claim of No. 4,321 is not a claim merely for the product of the process described in it, but is a claim for anything which may be called artificial alizarine, produced from anthracine or its derivatives, by either of the methods described, or by any other method, equivalent or not, which will produce anything called artificial alizarine. The scope of such a claim is seen in this suit. An article is sought to be covered by the reissue, which it is demonstrated Graebe and Liebermann never made by their bromine process, which they knew that process would not produce, which they recognized as produced first by some one else by a different process, and which has become the subject of a large industry abroad and an extensive use in this country, through discoveries made, as they

acknowledge, since their bromine process was invented. After those discoveries were made, after it was seen that the bisulpho-acid process would produce desirable dye-stuffs, and could be worked practically and profitably to that end, it was sought to control the market for the product in the United States, by obtaining this reissue No. 4,321." (311-312)

TURNER & SEYMOUR MFG. CO. v. DOVER STAMPING COMPANY, 111 U. S. 319 [1884]

Interval—12 years

Motive of Reissue—To enlarge specification and claims for dominating interim devices.

Subject Matter—The patents dealt with a familiar form of egg beaters. The original was limited to a specific series of illustrated cutting edges. The reissue covered every rotating beater frame formed of thin blades.

HELD

"We are quite satisfied that the difference between the original claim and the first claim of the reissued patent, is substantial and not verbal. The former is necessarily limited to the particular device described as a frame, with a series of cutting edges attached, in the mode designated, and capable of rotation. The latter embraces every revolving beater-frame, formed of thin, plain blades or cutters, arranged to cut edgewise through the material by their rotation. It is immaterial whether or not the latter might have been covered by the language of the specification, as included in the invention. We are dealing with the claims, and nothing else. And it cannot be successfully contended that the original claim implicitly contained all that is expressed in the claim of the reissued patent. The original claim has been made broader by the reissue, so as

to embrace the device used by the appellants, which was not previously an infringement.

And that raises the question, whether, under the circumstances disclosed by this record, the reissue is valid.

To avoid this question, it is, indeed, contended now by the appellees, that the two claims under examination are identical; that their apparent differences are merely literal; that their meaning is the same; and this conclusion is thought to be reached, not by restraining the reissue to the language of the original, but by a process of construction, by the use of supposed implications, to expand the words of the original so as to cover everything embraced in the reissue; the only alternative, indeed, that could be adopted, to escape the inconsistency of maintaining that claims, which were diverse upon the question of infringement, were identical upon the question of the validity of the patent.

But, as already intimated, this position is not tenable. There is nothing in the language or recitals of the original patent, nor are there any just and reasonable inferences of which they are susceptible, which justify a construction of the claim that would embrace any device other than that described in the specifications and represented in drawings; much less to include every mechanical arrangement which embodies a cutting edge with a revolving frame, to cut instead of break the egg material upon which it is meant to operate.

The question then recurs, what are the circumstances which affect the validity of the reissue, and how do they affect it?

They are few, but decisive. The original patent was issued July 7th, 1863. Eleven years after, in 1874, the competition of the appellants' device became apparent and was felt. In 1875, application was made for the reissue; the original patent was surrendered and the reissued patent granted, July 13th, 1875. Here is a delay of nearly twelve years, without the offer of an explanation or excuse, with-

out even the suggestion of inadvertence or mistake in the original application. The only inference that can be drawn is, that the discovery and experience of successful competition in 1874 suggested first and led to the discovery, that the original claim did not cover everything that might have been embraced, and was not broad enough to maintain the monopoly desired but not secured.

This brings the case directly within the principle of *Miller* v. *Brass Company*, 104 U. S. 350, and the numerous others which have followed it, including that of *Clements* v. *Odorless Apparatus Company*. 109 U. S. 641, all of which have been decided since the interlocutory decree in this case was pronounced." (325-327)

MAHN v. HARWOOD, 112 U. S. 354 [1884]

Interval—4 years

Motive of Reissue—To broaden claim after too long delay.

Subject Matter—The invention was in a leather cover for baseballs. The original claimed a combination of inner and outer covers with seams at right angles and also a special double herring-bone stitch in combination with two covers arranged to have break-joint seams. The reissue was broadened and claimed a cover of two parts secured by a single seam and also the herring-bone stitch alone. The description was not substantially altered and the object of the reissue was to broaden the claim. The subject matter was simple and readily understandable and the Court in this case laid down the rule that delay of more than two years prevented reissuance merely for broadening claims.

HELD

"The whole invention claimed, therefore, in the original patent, was, first, the two leather covers (an outside one

and and inside one), with their respective seams crossing at right angles; and second, the double herring-bone stitch in combination with the two covers." (356).

"It is apparent that, in the reissue, the claim of invention is greatly enlarged. The patentee claims therein, first, any and every single base-ball cover formed of two pieces of leather, fastened together by a single seam, substantially as and for the purpose described; secondly, any and every base-ball cover having its seam united by the double herring-bone stitch, substantially, &c.; thirdly, every and any use of two covers on a base-ball, each made of two pieces of leather, and applied to the ball independently of each other, substantially, &c. The fourth claim is nearly equivalent to the first claim of the original patent. The others are all new.

It is clear, therefore, on the face of the patents, that the only object of the reissue was to enlarge the claims. The description was not altered in the least. The claims in the original patent were clear and explicit, one of them being substantially retained in the reissue. Nothing was altered, nothing was changed, but to multiply the claims and to make them broader." (357)

"Conceding that it is for the Commissioner of Patents to determine whether the insertion of too narrow a claim arose from inadvertence, accident or mistake (unless where the matter is manifest from the record), the question whether the application for correction and reissue is or is not made within reasonable time is, in most if not all of such cases, a question which the court can determine as a question of law, by comparing the patent itself with the original patent, and, if necessary, with the record of its inception. The reason for this was fully explained in the case of *Miller* v. *The Brass Company*." (360)

"The public has the undoubted right to use, and it is to be presumed does use, what is not specifically claimed in the patent. Every day that passes after the issue of the patent adds to the strength of this right, and increases the barrier against subsequent expansion of the claim by reissue under a pretense of inadvertence and mistake. If any such inadvertence or mistake has really occurred, it is generally easily discernible by an inspection of the patent itself; and any unreasonable delay in applying to have it corrected by a surrender and reissue is a just bar to such correction. If the specification is complicated and the claim is ambiguous or involved, the patentee may be entitled to greater indulgence; and of this the court can rightfully judge in each case. No precise limit of time can be fixed and laid down for all cases. The courts will always exercise a proper liberality in favor of the patentee. But in any case, by such delay as the court may deem unnecessary and unreasonable, the right to a reissue will be regarded as having been abandoned and lost, and the Commissioner will be held to have exceeded his authority in granting it. Whenever it is manifest from the patent itself, compared with the original patent and cognate documents of record, or from the facts developed in the case, that the Commissioner must have disregarded the rules of law by which his authority to grant a reissue in such cases is governed, the patent will be considered as void to the extent of such illegality. It is then a question of law, not a question of fact." (361-362)

"The specification is very plain and free from complexity, and as we have already stated, the claims in the original patent were clear and explicit. There was no ambiguity, and nothing to prevent the patentee from seeing at once, on inspecting his patent, whether his whole invention was claimed or not. We can see no possible excuse, and none has been attempted to be shown, for

allowing the patent to stand the length of time it did without any attempt to have it amended. The reissue was made against law apparent on its face, and nothing is shown in the record to remove this illegality. The case is clearly within the principle laid down in *Miller* v. *The Brass Company*, and the patent must be regarded as void so far as the new and expanded claims are concerned." (363)

TORRENT ARMS LUMBER COMPANY v. RODGERS, 112 U. S. 659 [1884]

Interval—5 years

Motive of Reissue—To alter disclosure and enlarge claim to dominate interim machine.

Subject Matter—The patent was for a machine for turning logs on the carriage of a saw-mill.

HELD

"In the reissue the specification is modified so as to make a radical change, not only in the purpose, but in the mechanism of the invention. In the original patent the invention was declared to be an improved device for turning or rolling logs upon the carriage of a saw-mill. In the reissue the invention was declared to be a device for turning or rolling logs *to or* upon the carriage. The device, as described in the reissued patent, is adapted, not only to turn logs on their axes, but to roll them from one place to another, as from one part of the log-deck to another, or from the log-deck to and upon the carriage. This requires a change of mechanism. To turn a log when on the carriage without change of its location requires that the toothed-bar should be placed as closely as possible to the side, or within the side of, the carriage, and there must be knees to prevent a change in the location of the log.

To roll a log to the carriage, or to roll a log from the log-deck upon the carriage, the toothed-bar must be at a distance from the carriage at least as great as the diameter of the log, and the slot in which it works must be extended accordingly, and the knees are not only unnecessary, but would be an obstruction to the operation of the device." (667)

"The change of the specification, therefore, includes an omission of the knees, a change in the location of the toothed-bar, a change in its movements, and a change in the effect produced by its movements. The reissue, consequently, covers a different invention from that described in the original patent. It embraces a different machine, intended for different purposes and performing different functions, from that described in the original patent." (667-668)

"We find, therefore, that the specification and first claim of the reissue was an enlargement of the claims of the original patent, and covered an invention not covered or described therein; that the reissue was not applied for until nearly five years after the date of the original patent, and not until another inventor had made a substantial advance in the art to which the original patent belonged, which the assignee of the original invention, it may be fairly inferred, desired to include in the monopoly of his patent, and that he sought to accomplish this by its reissue. The first claim of the reissued patent was therefore void." (669)

Coon v. Wilson, 113 U. S. 268 [1885]

Interval—3 months

Motive of Reissue—To change description and enlarge claim to dominate interim marketed product.

Subject Matter—The original patent was for a collar having two short bands stitched along the bottom and with their ends projecting beyond the front and provided with button holes. The reissue was changed to cover a continuous band.

HELD

"The defendants' collars have bands which are continuous from end to end of the collar, and are not in two parts, nor divided by any vertical or other seam, at the centre of their length or elsewhere. They have no short or sectional bands, which start from the centre of the collar, or from any point between the centre and the ends. The band is not shorter than the length of the collar. In the original patent, the invention is stated to be a collar having short or sectional bands, that is, the collar has not a continuous band, of one piece of cloth as long as the collar, and extending from end to end of the collar, but has its band made in two sections, and each of those sections starts or begins to run from the centre of the length of the collar, or from a point between the centre and the end, to and beyond the end. The bands have a graduated curve and increasing width, from their starting points, to and beyond the ends of the collar. But that is only one feature in the claim of the original patent. The other feature, the sectional bands, is made equally important in that claim, and a collar is not the collar of that claim unless it has both of those features. That claim is limited to a collar with those features, 'substantially as described and shown.'" (275)

"The defendants' collars were first made and sold after the original patent of Wilson was granted, and after the defendants had seen sectional band collars made under it. The first of the defendants' four collars was made and sold in February 1878, and the other three in March, or

April, or May, 1878. The reissue was applied for March 11, 1878 and Wilson testifies that his impression is, that he had previously heard of the defendants' collars. It is evident that the reissue was obtained because of defendants' collar, with a continuous band, had been put on the market, and for the purpose of obtaining claims which would certainly cover such a collar. The changes made in the specification and claims show this. The specification of the reissue, in stating what the invention consists of, omits the statement that it is a collar having *sectional* bands, and states that it is a collar having *curved and graduated* bands. It also omits the statement that bands *start* from the centre, or from a point between the centre and the ends, and states that the curved and graduated bands *extend along the lower edge of the collar*, from the centre, or from a point between the centre and the ends." (276)

"Although this reissue was applied for a little over three months after the original patent was granted, the case is one where it is sought merely to enlarge the claim of the original patent, by repeating that claim and adding others; where no mistake or inadvertence is shown, so far as the short or sectional bands are concerned; where the patentee waited until the defendants produced their continuous band collar, and then applied for such enlarged claims as to embrace the defendants' collar, which was not covered by the claim of the original patent; and where it is apparent, from a comparison of the two patents, that the reissue was made to enlarge the scope of the original. As the rule is expressed in the recent case of *Mahn* v. *Harwood*, 112 U. S. 354, a patent 'cannot be lawfully reissued for the mere purpose of enlarging the claim, unless there has been a clear mistake, inadvertently committed, in the wording of the claim, and the application for a reissue is made within a reasonably short period after the original patent was granted.' But a clear mistake, inadvertently committed

in the wording of the claim, is necessary, without reference to the length of time. In the present case, there was no mistake in the wording of the claim of the original patent. The description warranted no other claim. It did not warrant any claim covering bands not short or sectional. The description had to be changed in the reissue, to warrant the new claims in the reissue." (277)

EACHUS v. BROOMALL, 115 U. S. 429 [1885]

Interval—1½ years

Motive of Reissue—To claim broader subject matter than novelty permitted.

Subject Matter—The original narrowly claimed a combination of structural elements in a machine for cutting paper. The reissue claimed the process of sawing paper-board in the wet state as taken from the paper making machine.

HELD

"A comparison of the two patents, for the purpose of determining the question raised as to the identity of the inventions described in them, requires an interpretation of the original patent in the light of the state of the art at the date when the application for it was filed." (434)

"It is manifest, from this state of the art, that it was not open to the appellant, at the time he applied for his patent, to claim as his invention the discovery that heavy paper, intended for the use of bookbinders and box-makers, could best be cut into proper shapes and sizes, while in wet sheets, as they came from the machine, nor that the cutting could best be performed by cutters with serrated edges. For this was matter of general knowledge and common practice." (435)

"It is plain, then, that the only invention exhibited in the drawings, or described in the specifications of the original patent, consists in the particular organization of the machine described, whereby the various parts are combined and adjusted, so as to fit it to accomplish the specific result of cutting heavy paper when in large sheets and in a wet condition, as received from the paper-making machine, into smaller sizes and other shapes, for use as boards in bookbinding and box-making." (436)

"We turn now, for the purpose of comparison, to the reissued patent. In the specification thereto the patentee declares that he has invented, not a machine, but 'a new and improved process of cutting paper boards,' of which a description follows; that the drawings referred to are views of 'my machine for conducting my process;' that the invention consists 'in subjecting paper, while in a wet state, as it is taken from the paper-making machine, to the action of circular cutters having serrated edges, whereby the sheets are cut evenly and economically, and the trimmings can be returned to the paper machine without regrinding or other treatment * * * .'" (436)

"A comparison of the two patents makes it very clear, that, if the patentee had in fact conceived the idea of enlarging the scope of his invention by development from a machine into a process, he has taken no pains to conceal or disguise his purpose. For he entitled his original patent as for a new and useful machine for cutting paper boards, while with equal explicitness, in his reissue, he declared that he had invented a new and improved process of cutting paper boards." (437-438)

"The patent is plainly limited by its language to the combination, arrangement and adjustment of the particular parts of the very machine described, for the uses to which

it is declared to be applicable. On the other hand, the claim of the reissue patent is broad enough to cover the process of sawing paper boards in a wet state by means of a hand-saw; and if, for the purpose of saving it from the necessary consequences of such a claim, it is restrained by construction so as to include only the process described when performed by means of circular cutters having serrated edges—terms of limitation to be found in the specification—it is still broad enough to cover every arrangement, combination and adjustment in which these elements may be found; and this surely is not the same invention as that described in the original patent." (438-439)

BROWN v. DAVIS, 116 U. S. 237 [1886]

Interval—11 years

Motive of Reissue—To enlarge description and claim to dominate interim marketed machine.

Subject Matter—The patents were for grain drills. The original had three claims to particular combinations of elements in the machine. The reissue added additional claims to broader sub-combinations of elements.

HELD

"In order to determine what construction ought to be given to the other claims of the reissue, it is necessary to consider an invention made by one Powers, at Madison, Wisconsin, in 1862, the invention of Davis being carried back only to September, 1866." (250)

"In view of this invention of Powers, we are of opinion that the invention of the Davis patent must be limited, so far as the shifting apparatus is concerned, to the special arrangement of the rotating crank-shaft described, and

shown in the drawings. The words 'substantially as described,' found in each of the first two claims of the original patent, properly confined those claims to the shifting mechanism described. If claim 1 of the reissue is given a construction which includes any arrangement for shifting not substantially using a rotating crank-shaft, it becomes a claim which could not lawfully have been granted in the original patent; and, as a claim in a reissued patent, it is invalid, within the defences set up in the answer, because the application for the reissue was made nearly eleven years after the original patent was granted, and after machines effecting the shifting by other means than a rotating crank-shaft had gone into use subsequently to the date of the original patent, and no sufficient excuse is given for the laches and delay. The same remarks apply to claim 3 of the reissue.

In view of the rulings of this court on the subject of reissued patents, made since the decision in this case was made by the court below, in May, 1881, this case must be considered in view of the fact that the new matter introduced into the specification of the reissue was put in for the purpose of reaching machines which the claims of the original patent would not reach, and of laying a foundation for claims 1 and 3 of the reissue." (251)

GARDNER v. HERZ, 118 U. S. 180 [1886]

Interval—7 years, 5 months

Motive of Reissue—To claim substantially different subject matter.

Subject Matter—An original patent issued in May 1872. It was first reissued in July 1876 and a second reissue (in suit) was granted, February 1880. The patents dealt with laminated veneer chair seats.

HELD

"While the first reissue was in life the owners of it brought a suit in equity against the present defendants, in the same court, alleging infringement of the first five claims of the first reissue." (187)

"The conclusion of the court was, that there was nothing new or patentable in the first five claims of Gardner's first reissue, in view of the patents referred to. It was not claimed that the sixth claim of that reissue had been infringed." (188)

"A little over five months after this decision was made, the second reissue was applied for, and about four months after it was granted this suit was brought." (188)

"• • • the Circuit Court held, in this case, that the only question open, as to the second reissue, was, whether the concavity of form, made an element of the second claim of that reissue, would support the patent. Concurring, as we do, in the views and conclusions of the court, and finding them well expressed in its opinion, we repeat them here: • • •

'If there was no patentable novelty in using the perforations of the metal or gutta-percha chair-seats in the veneer seat by Gardner, neither can there seem to be any in employing a well-known form of chair seat in his veneer seat.' • • •

'In conclusion, in view of the former decision of this court, the complainant can only succeed upon the theory that, by imparting a concave form to his chair-seat, he has imparted sufficient patentable novelty to his article to sustain a patent; and this when such a form of chair-seat was old, the material used was old,

and the method of imparting the form to the material was old. This theory cannot stand.'" (189-190)

"The fabric being old, the suggestion to construct chair-seats out of it being old, the shaping of it in a former being old, the perforation of a seat for ventilation and ornamentation being old, and the giving of a concave shape to a wooden seat by pressure being old, there cannot, in view of the disclaimers in the second reissue, be anything patentable in the structure. It was convenient to sell and convenient to buy, and commercially a good article. But a patent cannot be taken out for an article, old in purpose and shape and mode of use, when made for the first time out of an existing material, and with accompaniments before applied to such an article, merely because the idea has occurred that it would be a good thing to make the article out of that particular old material. Beyond that, the suggestion in the second reissue, that 'the seat is adapted to be secured to any chair-frame, as it is easily cut and fitted to the same,' is not found in the original patent, or in the first reissue; and is new matter, so far as anything in it can be invoked to confer patentability on the article." (192)

WHITE v. DUNBAR, 119 U. S. 47 [1886]

Interval—5 years

Motive of Reissue—To enlarge specification and claims to dominate interim article.

Subject Matter—The original patent was for an improved method of canning shellfish, which included placing a textile fabric between the metal can and the contents. The reissue claimed interposing a protective material between the can and the contents. The reissue was held barred as violating the two year rule against patent reissues.

HELD

"We are clearly of opinion, therefore, that the original patent is not susceptible of the broad construction which the appellees would give to it; and that the reissued patent is a material expansion and enlargement of it. As such expansion appears to be the only object of the reissue, and as the application for the reissue was not made until nearly five years after the original was granted, the case comes within the ruling of *Miller* v. *Brass Company*, 104 U. S. 350, and subsequent cases to the same purport." (52)

NEWTON v. FURST AND BRADLEY COMPANY,
119 U. S. 373 [1886]

Interval—13 years

Motive of Reissue—To change the disclosure and broaden claims to dominate interim marketed machines.

Subject Matter—The patents dealt with gang plows. The original narrowly claimed the combinations of particular elements. The reissue claimed broader subcombinations. The prior art showed the invention narrow.

HELD

"The Circuit Court was of opinion, that, if the state of the art was such as to entitle Davenport to a broad claim for any device by which the plough is lifted by the power of the team through a brake or friction-clutch, the defendants' machine would infringe. But the court found that, prior to Davenport, devices had been used in agricultural implements for utilizing by means of a brake the motion of the carrying-wheel, through a crank-axle, in raising operative parts of the machine from the ground, which devices were so alike in structure and so analogous in use to those of Davenport, as to require his claims to be lim-

ited to his specific devices. In view of those prior devices the Court held that the defendants' friction-band could not be regarded as the same means for engaging and disengaging the carrying-wheel and the axle as the brake of Davenport; and that the defendants' crank-axle was not the plaintiff's hinged board. In these views we concur.

The reissue was applied for more than thirteen years after the original was granted, and after the defendants had begun to make machines of the pattern now complained of. The original patent did not make a swing-axle and a carrying-wheel elements in the combination of the first claim of that patent. The reissue was evidently taken to cover the defendants' machine, which did not infringe the first claim of the original patent, because it did not have the Davenport brake R. No mistake or inadvertence is shown." (384-385)

IVES v. SARGENT, 119 U. S. 652 [1887]

Interval—3½ years

Motive of Reissue—To dominate interim device

Subject Matter—The patents dealt with door bolts. The original claimed certain combinations of particular elements and the reissue added a claim to a different combination and a claim to a single element.

HELD

"The whole question is, whether the patentee and his assignee are entitled, under the circumstances of the case, to claim the pitman E, operating as a pitman and spring in a door-bolt, as a distinct and separate invention, irrespective of its combination with the exterior and interior cases mentioned in the first and second claims." (658)

"On this application the patent was issued, and it does not appear to have been read or examined by any of the parties in interest until after the appellee commenced making the bolts now alleged to be an infringement. It was then discovered for the first time that the original patent did not cover the claim as now made, and the reissue was obtained to effect that purpose." (660)

"In the present case no special circumstances in excuse for the delay are alleged. The excuse proffered is simply an attempt to shift the responsibility of the mistake, as originally made, from the patentee to his solicitor; but no excuse is offered why the patentee did not discover the negligence and error of his solicitor in due time. On the contrary, he assumed, without examination, that the specification and claims of his patent were just what he had desired and intended they should be, and rested quietly in ignorance of the error and of his rights for nearly three years, and then did not discover them until after others had discovered that he had lost the right to repair his error by his neglect to assert it within a reasonable time.

We are, therefore, of opinion that the Circuit Court was clearly in the right in deciding the reissue void as to the third and fourth claims, on the ground that the right to apply for it had been lost by the laches of the patentee and his assignee." (662)

"We are also of opinion, however, that the reissue is void on the other ground, viz., that it contains new matter introduced into the specification, and that it is not for the same invention as that described in the original patent." (p. 662)

"There is nothing whatever in the drawings to show that the patentee claimed to be the inventor of that part separate from the combination, as a distinct novelty, useful by

itself, or in any other combination; neither is it so described in the specification." (662-663)

"We are, therefore, constrained to the conclusion that the addition of the third and fourth claims, with the corresponding alterations in the specification, is such an expansion of the invention as originally described as to destroy its identity, and to that extent to avoid the reissued patent." (663)

HARTSHORN v. SAGINAW BARREL COMPANY,
119 U. S. 664 [1887]

Interval—9 years

Motive of Reissue—To enlarge disclosure and to copy broader claim obtained by another nine years before.

Subject Matter—Structure of Window Shade Rollers.

Fact Summary: Independent inventors Hartshorn and Campbell employed the same solicitor to obtain their patent. The solicitor assumed that Hartshorn had priority and obtained a broad claim in the Hartshorn patent and a narrow claim in the Campbell patent. Nine years later correction was sought by reissue to put the broad claim in the Campbell patent.

HELD

"Campbell's acquiescence in Hartshorn's claim must be regarded, so far as he is concerned, as an abandonment of any right on his part to a patent for the same invention, and, having deliberately rested in that acquiescence for a period of between nine and ten years, it is too late, according to the settled source of decisions in this court, to resume his rights. * * *

Campbell contented himself with the narrow claim originally contained in his patent of 1867, and thereby acknowledged that he was not entitled to the broader claim which he now asserts under his reissue. He had the means and the opportunity at the time the application for his original patent was pending to have asserted his claim to priority of invention; he chose not to do so. He acquiesced in the claim of his adversary; he cannot now claim what he then abandoned." (674-5)

" * * * the reissue of the Campbell patent was not for the same invention described and claimed in the original. This does not rest merely on the enlargement and change in the nature of the claim. The specification itself was substantially altered. The alterations, it is said in argument, had the effect only of giving a more full, complete, and accurate description of the same mechanism; but, in point of fact, the alterations changed the shape of the specification in such a way as to admit the new and enlarged claim in a manner in which it could not have been made upon the original description. A comparison between the original and reissued patents shows that the specification of the latter has been materially changed so as to cover, as the invention of the patentee, that function of the structure by which the spring will be locked when the roller as a whole is removed from the brackets, in respect to which the original patent is entirely silent." (675)

"In order to understand and resolve the questions arising in the case it will be necessary to consider the state of the art at the time of the issue of the patents." (665)

WORDEN v. SEARLS, 121 U. S. 14 [1887]

Interval—6 years

Motive of Reissue—To enlarge claims to cover interim device.

Subject Matter—The original showed and claimed a whip-socket comprising a holder and pivoted lever to hold the whip steady. The reissue broadened the claim to cover the pivoted lever alone and also in combination with any stationary part of a socket.

HELD

"The specification of the original Scott patent stated the invention to be 'a new and improved fastening applied to a whip-socket'. The socket is described as a complete whip-socket, complete in itself without the fastening, and having in its side an opening or slot, extending nearly its whole height or length, in which slot is inserted a lever. The claim is for 'a whip-socket,' that is, a complete whip-socket, 'provided with a fastening composed of a lever, arranged or applied substantially as shown and described,' that is, inserted in the slot in the socket. The defendants' structure consists only of two sectional halves, each like the other, and each a cone-shaped half-cylinder, and bilged, with an ear-shaped hinge on each half-section, a rivet connecting the two forming the hinge. This arrangement does not infringe the claim of the Scott original patent. It is not a complete whip-socket provided with a lever arranged or applied substantially as in Scott's apparatus, that is, pivoted in a slot in the socket. It is true that the result in each arrangement is to hold the whip steady or firm in a socket, but the mechanisms are different.

That the specification and claims of the reissue were designedly so worded as to cover a structure which the claim of the original patent would not cover is manifest.

Thus, the original specification says that the invention relates to a 'fastening applied to a whip-socket in such a manner as to hold the whip firmly therein.' This means that you have a complete whip-socket and you apply a fastening to it, which fastening is so arranged as to hold the whip firmly in the socket in which the whip is placed. The description in the original specification describes a complete whip-socket, with an opening or slot in the side of the socket, extending nearly its whole height or length, with a fastening lever secured in the slot by a fulcrum-pin rather below the centre of the lever, the lever having near the fulcrum-pin a weighting projection, b'. The reissued specification says that the 'improvements consist in the use of a lever with the stationary or upright portion of the socket'. The socket is referred to as if it had a part which is not stationary. The first and second claims carry out the same idea, by making the 'stationary part' of the socket an element in each of those claims. The defendants' holder is not a complete holder with its stationary part alone, and without its movable part, while the plaintiff's is. Moreover, all mention of the weighting projection b' is omitted in the reissued specification. The design manifest in it is to cover such a structure as that of the defendants, and the evidence tends to the conclusion that that was the object of obtaining the reissue. The description and claim of the original specification were entirely adequate to cover the Scott device. No inadvertence, accident or mistake is shown.'' (23-24)

EAMES v. ANDREWS, 122 U. S. 40 [1887]

Interval—3 years

Motive of Reissue—To modify description and broaden claim to effectuate invention.

Subject Matter—This case dealt with the driven well patent. The original and reissued claims read:

Original	Reissue
The herein described process of sinking wells where no rock is to be penetrated, viz.: by driving or forcing down a rod to and into the water under ground, and withdrawing it and inserting a tube in its place to draw the water through, substantially as herein described. (47)	The process of constructing wells by driving or forcing an instrument into the ground until it is projected into the water without removing the earth upward, as it is in boring, substantially as herein described. (47)

HELD

"The particulars relied on to establish the proposition that the reissued patent describes a different invention from that contained in the original are as follows: 1st. It is said that it is essential to the success of the process that the end of the tube should form an air-tight connection with the surrounding earth; that the tube itself should be air-tight, and attached to a pump with an air-tight connection; which elements are set out in the reissued patent, and are not contained in the original." (56)

"To this view there are two sufficient answers.

1st. We think it is a reasonable inference, from the language employed in the specification of the original patent, that the tube, in the act of being driven into the earth, to and into a water-bearing stratum, would form an air-tight connection with the surrounding earth, and that the pump should be attached by an air-tight connection. This inference reasonably follows from the fact, shown in the evi-

dence, that the mere act of driving the tube, as distinguished from boring, usually results in making an air-tight connection with the surrounding earth." (57)

"2d. But even if this were not so, the case would be simply that of a specification defective for not containing a full and perfect description of the process intended to be patented. It presents the very case of the right secured to a patentee by §53 of the act of July 8, 1870, which provides, 'that whenever any patent is inoperative or invalid by reason of a defective or insufficient specification, . . . if the error has arisen by inadvertence, accident, or mistake, and without any fraudulent or deceptive intention, the Commissioner shall, on the surrender of such patent and the payment of the duty required by law, cause a new patent for the same invention, and in accordance with the corrected specification, to be issued to the patentee,' &c.

If the amended specification does not enlarge the scope of the patent by extending the claim so as to cover more than was embraced in the original, and thus cause the patent to include an invention not within the original, the rights of the public are not thereby narrowed, and the case is within the remedy intended by the statute." (59)

"There is nothing in these additions and amendments which either was not virtually contained by reasonable implication in the original description, or, if new, amounted to more than specific and exact directions to supplement those contained in the original. The invention is not differently described, and is not described so as to be a different invention, nor is the claim enlarged." (60)

"The object and purpose of the amendments to the specification obviously were to meet a possible construction of the original, whereby the patentee would be precluded from the use of his process where it was evidently intended to

be applied, simply because one or more strata of rock had to be penetrated in the process of driving. Such, in our opinion, is not the meaning of the original patent." (62)

"In our opinion, therefore, the grounds on which it is sought to invalidate the reissued patent, as being for a different invention from that described in the original, cannot be sustained.

This conclusion is not in conflict with anything said in *Russell* v. *Dodge*, 93 U. S. 460, 463." (62-63)

PARKER AND WHIPPLE COMPANY v.
YALE CLOCK COMPANY, 123 U. S. 87 [1887]

Interval—1 year and 8 months

Motive of Reissue—To add claim to a different combination of elements to dominate interim marketed device.

Subject Matter—The patents dealt with clock movements. The original narrowly claimed combinations of particular elements. The reissue added claims to combinations of entirely different elements.

HELD

"'If the premise was true, they deny the conclusion, because it is a fact, the truth of which is apparent, that, in the original specification and drawings, the patentee gave no hint that he regarded the construction described in any one of the first eight claims of the reissue as forming any material or immaterial part of his invention.'

On these premises, the court said that 'the eight claims which are in controversy are a total abandonment of the principles which are stated in the original patent to be those of the invention, and are an introduction into the reissue of a subject-matter which has no relation to the original patent, except that each patent relates to clocks.'" (92)

"In these extracts from the opinion it is seen that the court adheres strictly to the view that, under the statute, the Commissioner has no jurisdiction to grant a reissued patent for an invention substantially different from that embodied in the original patent, and that a reissue granted not in accordance with that rule is void. In what is there said about redescribing the invention, and about including in the new description and new claims what was suggested or indicated in the original specification, drawings or patent office model, it is clearly to be understood, from the entire language, that the things so to be included are only the things which properly belonged to the invention as embodied in the original patent; that what that invention was is to be ascertained by consulting the original patent; and that, while the new description may properly contain things which are indicated in the original specification, drawings or patent office model, (though not sufficiently described in the original specification), it does not follow that what was indicated in the original specification, drawings or patent office model is to be considered as a part of the invention, unless the court can see, from a comparison of the two patents, that the original patent embodied, as the invention intended to be secured by it, what the claims of the reissue are intended to cover.

In what was thus said in *Seymour* v. *Osborne*, there is no warrant for the view, that, *ex vi termini*, what was suggested or indicated in the original specification, drawing or patent office model is to be considered as a part of the invention intended to have been covered by the original patent, unless the court can see, from a comparison of the two patents, that the invention which the original patent was intended to cover fairly embraced the things thus suggested or indicated in the original specification, drawings or patent office model, and unless the original specification indicated that those things were embraced in the invention intended to have been secured by the original patent." (98-99)

"If by 'new matter,' in §4916 of the Revised Statutes, is meant such new substantive matter as might be the subject of another application for a patent, there was new substantive matter introduced into the specification of the reissue in the present case; for the description set forth in that specification as the foundation for the first eight claims in it, and those eight claims themselves, might have been the subject of another application for a patent, at the time the original patent was applied for and taken out, leaving that patent valid and operative in respect to the claims it covered.

In the present case, the infringing clock was made by the defendant Lane more than six months before the reissue in suit was applied for. As stated by the Circuit Court in its opinion in this case, the Lane clock did not contain a single patented feature of the Hotchkiss clock, and it was immediately patented and put upon the market. This, therefore, is a case of the amendment of a patent so as to cover improvements not covered by the patent, and which came into use by others than the patentee and his licensee, free from the protection of the patent." (102)

MATTHEWS v. IRONCLAD MANUFACTURING COMPANY, 124 U. S. 347 [1888]

Interval—7 years

Motive of Reissue—To enlarge claims to dominate interim marketed device.

Subject Matter—The patents dealt with soda water fountains and the original claimed a vessel of tin enclosed by a cylinder of steel with a solder of pure tin. The reissue omitted the limitation that the cylinder should be steel and omitted the soldering connection.

HELD

"But the only claim of the original patent is for 'the tin vessel, incased by a steel cylinder, and ends soldered to the latter, in the manner substantially as described;' and the manner described in the specification of fastening the end caps to the body of the outer shell is, 'without flanges or projections, by tin joints, made by soldering with pure tin, which, being a ringing metal, unites closely with the steel exterior to make a firm and durable joint, as other solders having lead in them will not do.'

The patentee himself testified that when he made his invention he knew of others having used iron fountains lined with sheet block tin; that the first fountains he made were soldered with tin and lead solder, usually known as soft solder, and he found that would not do, and therefore adopted a solder of pure tin; and that he dispensed with rivets, because they prevented the fountain being repaired without tearing the shell in taking out the rivets.

In short, by the term of the specification and claim, in the then existing state of the art, and according to the intention of the patentee, his patent was limited to a fountain in which the caps were connected with the outer cylinder by pure tin solder, without rivets or flanges.

In the fountain made by the defendant, on the other hand, the caps are fastened to the body at both ends by a solder of half tin and half lead, as well as by rivets, and there are vertical flanges at one end, through which the rivets pass. It is quite clear, therefore, that if the original patent had remained unaltered, there would have been no infringement.

The reissue was taken out seven years after the original patent, and a year or two after the patentee knew that the defendant was making such a fountain as is now alleged to be an infringement.

The repetition of the original specification in the reissue, word for word, (except only in the unimportant variation

of omitting the word 'closely' in speaking of the fitting of the shell to the lining), as well as the testimony of the patentee, proves that there was no defect or insufficiency in the original specification, and no error, inadvertence or mistake in framing it.

If the omission, in the claim of the reissue, after the mention of the outer cylinder and the ends, of the words 'soldered to the latter,' before the words 'in the manner substantially as described,' still leaves the claim to be construed and limited by the previous description in the specification, the patentee is no better off than if he had not taken out a reissue.

But if the effect of omitting the words in question is to extend the claim to a fountain, the outer cylinder and ends of which are fastened together in any other manner than by a solder of pure tin, the claim is enlarged by omitting an essential element of the patentee's invention, and the reissue is invalid, by the settled law of this court." (350-351)

YALE LOCK MFG. CO. v. JAMES, 125 U. S. 447 [1888]

Interval—8 years

Motive of Reissue—Enlargement of claim and disclosure to cover subject matter abandoned under pressure from Patent Office.

Subject Matter—The original disclosed and claimed individual metal fronts for post office boxes with flanges to overlap and with fastening rivets connecting the individual fronts to each other and to the rear wooden pigeon holes whereby continuous tamper-proof front was presented. The reissue claim was broadened to embrace individual boxes with contiguous but not overlapping flanges and with fastening means holding the individual fronts to the rear wooden pigeon holes but not to each other.

HELD

"In view of these facts, Judge Shipman, in his decision in the present case, said: 'It is unquestionable that the patentee, when he made his original application, intended to say that his invention did not consist simply in making, by his combination of metallic doors, door frames, and wooden boxes, a continuous metallic frontage, but that it also consisted in the way in which the frontage was made continuous, viz. by the connection of the adjoining frames with each other. His definite and exact specification shows that he supposed that his patentable invention was thus limited. He described with precision and clearness, that his metallic frontage was to be so constructed that the frames were to be fastened to each other at top, bottom, and sides, and not merely to the woodwork. 'A specific invention, complete in itself,' was described, 'fully and clearly, without ambiguity or obscurity.' Under the definitions which are given in the decisions which have been referred to, and in *Manufacturing Co.* v. *Ladd,* 102 U. S. 408, of the inadvertence, accident, or mistake which permits a reissue, when a patent is said to be inoperative on account of a defect or insufficiency in the specification, which arose through such inadvertence or mistake, and also of the nature of the defectiveness or insufficiency which is meant by the statute, there was no mistake, although the patentee might have fallen into an error of judgment, or to an erroneous conclusion of fact; and, furthermore, the original patent, according to the definitions contained in the recent, and, perhaps, in the earlier cases, was not defective nor insufficient, either in its descriptive portion or in its claims." (462-463)

"In view of the fact that the Patent Office excluded from the descriptive part of the specification suggestions of any other method of fastening than that by which the frames were to be fastened to each other, it would be singular if

the intent of the Office was to include in the second claim such other method of construction. If this claim has properly, and the applicant knew that it was intended to have, a narrow construction—and of this knowledge I think there can be little doubt—the plaintiff would not insist that the 1st and 2d claims of the present reissue ought, in view of the decision in *Miller* v. *Brass Co., supra* to be so construed as to be any broader than the 3d claim, which requires the combination of door frames, doors, and pigeon holes to be by means of rivets or bolts which attach the frames both to the wood-work and to each other." (463-464)

HOSKIN v. FISHER, 125 U. S. 217 [1888]

Interval—8 years

Motive of Reissue—To add broader claim to dominate interim marketed apparatus.

Subject Matter—The patents concerned hydraulic mining apparatus and the original claimed a combination of ten particular elements. The reissue claimed a single element for connecting two others.

HELD

"In the case of *Wollensak* v. *Reiher*, 115 U. S. 96, the following propositions were laid down by this court: (1) The question whether delay in applying for a reissue of a patent has been reasonable or unreasonable is a question of law for the determination of the court. (2) The action of the Patent Office in granting a reissue, and deciding that, from special circumstances shown, it appeared that the applicant had not been guilty of laches in applying for it, is not sufficient to explain a delay in the application which otherwise appears unreasonable and to constitute laches. (3) Where a reissue expands the claims of the

original patent, and it appears that there was a delay of two years, or more, in applying for it, the delay invalidates the reissue, unless accounted for and shown to be reasonable. These principles are applicable to the present case, and require that the decree of the Circuit Court should be reversed. The delay is not accounted for by the plaintiffs, nor shown to be reasonable." (222)

CORNELL v. WEIDNER, 127 U. S. 261 [1888]

Interval—8 years

Motive of Reissue—To broaden after too long delay.

Subject Matter—The patents dealt with a metal bushing for cask bungs. The original claimed the combination of a notched bushing with a wrench having a projection to fit the notch. It was first reissued in two divisions, one for the wrench and the other for the bushing. The bushing reissue was again reissued to enlarge the claim by omitting the notch.

HELD

"It thus appears that the original patent described a bushing with a V-shaped notch in the flange, and a wrench made with an angular projection to fit that notch, and applied by turning the wrench until the projection fell into the notch; and that all that the patentee claimed as his invention was the combination of the notched bushing with the wrench having a projection to fit it.

On August 6, 1872, the patent was reissued in two divisions No. 5026 (not in this record) being for the wrench, and No. 5027 being for the bushing, describing it as 'an angular ring of metal. * * * ' " (262-263)

"The specification and the claim of that reissue, as clearly appears upon its face, both treated the notch in

the flange of the bushing as an essential element of the invention." (263)

"On June 17, 1879, a second reissue, No. 8759, was obtained for the bushing, * * * " (264)

"The notch in the flange of the bushing is not mentioned either in the specification or in the claim of this reissue, although it is shown in the accompanying drawings, substantially as it was shown in the drawings of the original patent and of the former reissue.

The original patent and the first reissue having been distinctly limited to a bushing having a notch to aid in forcing it into place, the second reissue, obtained nearly seven years later, for a bushing without any such notch, is an unwarrantable enlargement of the supposed invention, which, according to the now well settled law, renders the reissue void." (264-265)

FLOWER v. DETROIT, 127 U. S. 563 [1888]

Interval—8 years

Motive of Reissue—To dominate interim marketed devices.

Subject Matter—The patents dealt with fire hydrants. The original narrowly claimed a combination of particular elements. The reissue broadly claimed a lesser combination.

HELD

"The material difference between the descriptive parts of the two specifications is that, in the reissue, it is stated that the casing C is movable, and that sufficient space is left between the bead *a* upon the hydrant proper, and the upper terminus of the casing C, to permit of sufficient up-and-down play of the casing C to allow it to slide

loosely up and down, to accommodate the upward and downward movement of the earth during the process of freezing and thawing, without any liability to derange the plug or hydrant. The casing could not thus slide loosely up and down, unless sufficient space were left between the bead *a* and the upper terminus of the casing. No suggestion of such arrangement is found in the specification of the original patent, and the drawing of that patent shows no space between the upper terminus of the casing and the bead or flange above it. This is a new matter introduced into the specification of the reissue, contrary to the express inhibition of §4916 of the Revised Statutes.

Claim 1 of the reissue is for an invention not indicated or suggested in the original patent, namely, the independent up-and-down motion of the casing. In addition to this, the drawing of the original patent shows a close contact between the top of the casing and the bead or flange above it, so as absolutely to forbid any such independent up-and-down motion of the casing as is covered by the first claim of the reissue, while the drawing, Figure 1, of the reissue, shows a sufficient space between the top of the casing and the bead or flange above it to admit of such independent up-and-down motion." (569-571)

"In the present case, it cannot be seen from a comparison of the two patents that the original specification indicated that what is covered by the first claim of the reissue was intended to have been secured by the original.

In the present case, also, the reissue was not applied for until nearly eight years after the original patent was granted, and the reissue was taken with the manifest intention of covering, by an enlarged claim, structures which in the meantime had gone into extensive public use, and which were not covered by any claim of the original patent." (571-572)

FARMERS' FRIEND MFG. CO. v. CHALLENGE CORN-PLANTER CO., 128 U. S. 506 [1888]

Interval—1 year, 11 months

Motive of Reissue—To change materially the claimed subject matter, to cover earlier art.

Subject Matter—The patents dealt with corn-planters.

HELD

"It thus appears that while the claims, both of the original patent and of the reissue, relate to a corn-planter having the rear main frame mounted on supporting wheels, and the front runner-frame hinged or pivoted to the main frame, the difference between them is this:

The claim in the original patent is limited to a lever having its front end slotted, and connected with the runner-frame by a bolt passing through the slot, in combination with a shaft journaled at one end to the main frame and at the other to the seat-standard, and with a lifting hand-lever rigidly attached to that shaft, for elevating, depressing and controlling the runner-frame.

In the reissue, on the contrary, the first and fourth claims undertake to cover any form of foot-lever or treadle and hand-lever used in combination for the purpose of elevating or depressing the runners; the second claim differs only in being restricted to a hand lock-lever used in connection with the foot-lever; and the third claim, in requiring the two levers to be rigidly connected.

In the Kelly machine, patented September 14, 1875, and in public use before the plaintiff's invention, a foot-lever and hand-lever had been used in combination, rigidly connected together, (certainly quite as much so as in the defendant's machine), and with a lock on the hand-lever.

The only feature of the plaintiff's machine which can possibly be considered as new is a slotted lever connected

with the runner-frame by a bolt, and the hand-lever mounted upon a shaft journaled at one end to the main frame and at the other end to the seat-standard, thereby facilitating the depressing of the runners by a single movement. The claim in the original patent is limited to a mechanism containing that feature which is not found in the defendant's machine. The enlargement of the claims in the reissue, so as to embrace machines not containing that feature, is void, under the rule established by recent decisions of this court, too numerous and familiar to require citation." (509-510)

PATTEE PLOW CO. v. KINGMAN, 129 U. S. 294 [1889]

Interval—2½ years

Motive of Reissue—To alter description of machine and correspondingly to alter claims in significant and material respects.

Subject Matter—The original disclosed and narrowly claimed a sub-combination of mechanical elements in cultivators. The reissue disclosed and claimed a different sub-combination of elements differently operating.

HELD

"The axle, having plates as described hinged to wheel-spindle plates, is not identical with an axle omitting the first-named plates, or having them so affixed as to become a constituent part thereof. The omission of the plates B and the addition of the direct draft are significant and material changes, and it is well settled that a reissue can only be granted for the same invention intended to be embraced by the original patent, and the specification cannot be substantially changed, either by the addition of

new matter or the omission of important particulars, so as to enlarge the invention as intended to be originally claimed.

Passing to the question of infringement, it will be found that when the extent of the invention is determined, as it must be, by reference to the state of the art, the appellee's machine does not infringe in respect to those parts of the claim which can be held to have been unanticipated." (299)

DOBSON v. LEES, 137 U. S. 258 [1890]

Interval—1 month

Motive of Reissue—To claim in the reissue, subject matter which had been deliberately waived during the prosecution of the application for the original patent.

Subject Matter—The original patent was applied for September 30, 1872 and was granted February 20, 1877. The reissue was applied for March 24, 1877 and granted March 7, 1882. The original patent was for a shaft and bearing of cast iron or of metal of the same crystalline structure as cast iron. The reissue was for a machine comprising a combination of elements.

HELD

"It appears from the record that James Greaves applied September 30, 1872, for a patent for an 'improvement in condensing cylinders for carding engines,' the proposed claim being: 'The application, as described, of cast iron spindles to the condensing cylinders of carding engines.'" (259)

"The application was rejected October 29, 1872, and again rejected December 7, 1872. On the 7th of December, 1874, the following was substituted for the claim: 'A spin-

dle for carding machine rollers, rectangular in form, for the purpose set forth.' This amendment was followed by a redrawn specification, the claim of which was as follows: 'The combination, substantially as described, of the condensing cylinder of a carding engine, the driving wheel A, the hub of which has a square or angular aperture, and the spindle X, having a corresponding shape imparted to that portion of it which slides through the said hub, all as set forth.' This specification was accompanied by a new sheet of drawings marked 'sheet 2,' the drawings originally filed being marked 'sheet 1,' and by a new model. A new oath of invention was required and made, dated January 22, 1875. On the 27th of January the claim of the amended specification was rejected upon reference to Davison and Crowther's English patent No. 2885 of 1856, and others; again rejected on the 26th of February in view of that reference, and also of the patents of Harraday, of May 30, 1854, No. 10,986, and of Warth, of August 6, 1872, Nos. 130,343 and 130,344; again, on March 31, 1875; again, on appeal to the board of examiners in chief, August 7, 1875; and again, by the Commissioner on appeal to him, November 11, 1875. There having been a change of attorneys, on the 12th of October, 1876, an amended specification was filed, and rejection again followed, November 27, 1876. The specification was again amended November 29, so as to set up these two claims:

> '1st. The combination, in a carding engine, of a condensing or rubber cylinder, a driving wheel, and a polygonally-shaped horizontal shaft or spindle, the latter being adapted to be revolved and at the same time to be continuously reciprocated in a correspondingly polygonally-shaped bearing, and a continuously reciprocating rubber, substantially as and for the purposes described.

'2d. In a carding engine, the combination of a continuously reciprocating rubber, a driving wheel to turn said rubber, and a horizontal shaft or spindle connecting the two together said shaft or spindle and the bearing in which it reciprocates being both made of cast iron, or both of metal having the same crystalline structure, whereby in the reciprocating action the tendency of the crystalline particles of cast metal in the bearing to wear the spindle will be resisted by the crystalline particles of the latter, substantially as and for the purposes described.'

This application was rejected December 1. The applicant appealed, and on December 2 the examiner reported that he had rejected the first claim, which did not then require that the spindle and bearing should be of cast iron, upon the ground that its non-patentability was *res adjudicata* so far as the examiner was concerned; and that the second claim was rejected because the substitution of the cast metal shaft for the wrought metal or steel shaft, before employed, required no invention. The examiners in chief, on the 15th of December, reversed the examiner's decision as to the second claim, but affirmed it as to the first, holding, however, that if the first claim were amended so as to include 'cast iron or metal of the same crystalline structure' for bearing and spindle, they thought it would be admissible. The first claim was accordingly amended by the insertion, after the word 'bearing', of the words 'said bearing and said shaft or spindle being of cast iron or of metal of the same crystalline structure.'

On the 11th of January, 1877, an interference was declared between these claims and the application of one Stone, and on the 8th of February, 1877, the examiner refused a motion to dissolve the interference, upon the ground that the feature which Greaves relied on as not shown in the Stone invention was that Greaves' shaft and bearing were made of cast iron of metal having the same

crystalline structure, while Stone's were of cast brass, which would come within the scope of Greaves' claims. It was held by the Assistant Commissioner, on appeal, on the 9th of February, that 'as cast brass has not the same crystalline structure as cast iron, the application of Greaves, if so amended in its claims as to restrict him to the use of metal having the same crystalline structure 'as cast iron,' will not interfere with an application showing and describing 'cast brass,' if the material is of the essence of the invention.' Applicant accordingly so amended February 9, the interference was dissolved February 10, and the patent was issued February 20, 1877.

The result of all this was, that after repeated attempts and repeated rejections, the patent was allowed, containing two claims, limited strictly to a shaft and bearing of cast iron or of metal of the same crystalline structure as cast iron." (259-261)

"Applications were then filed for a reissue in two divisions, A and B—for division A on March 24, 1877, and for division B on March 15, 1877." (262)

"The claim in Division A was as follows:

> 'In a carding engine, a condensing or rubber cylinder mounted on a polygonally-shaped horizontal shaft, in combination with a driving gear, A, having a sleeve-shaped bearing, *b*, said shaft and cylinder being adapted to be revolved by the drivewheel A, and at the same time to be rapidly and continuously reciprocated by suitable mechanism, substantially as and for the purposes described.'

And for this, reissued letters patent No. 10,054 were granted March 7, 1882, and this is the patent in controversy. Before it was passed for issue, various proceedings were had in the Patent Office, including rejections,

appeals, and disposal of an interference between this application and that of Stone, and it appears by the statement of Examiner Appleton, under date of December 5, 1881, that after the determination of the interference the application was returned to the examiner, 'with instructions to consider whether or not, in view of certain recent decisions of the Supreme Court of the United States, the same in its present form can properly be allowed.' The examiner was clearly of opinion that under the decisions of this court in *Powder Company* v. *Powder Works*, 98 U. S. 126; *Leggett* v. *Avery*, 101 U. S. 256; *Manufacturing Co.* v. *Ladd*, 102 U. S. 408; and *Goodyear Dental Vulcanit Rubber Co.* v. *Davis*, 102 U. S. 222, the applicant was not entitled to the claim presented, 'said applicant having withdrawn a similar claim in his original application in order to obtain his original invention and the present claim being for a different invention from that covered by the original patent.' And in his statement of grounds of decision, under date of January 27, 1882, the examiner gave as his reasons: 'In the first place, this claim, being for a combination of parts of peculiar construction, while the original is for a combination of parts when some of the same are constructed of particular metals, the metals being the gist of the claim thereof, is for a different invention from that covered by the original patent. In the second place, the claim now in controversy having been withdrawn from the application upon which the original patent was granted, with a full knowledge of all the facts in the case, it cannot be urged that such withdrawal of the claim, or any other change that the appellant now desires to make was the result of or necessitated by any inadvertence, accident, or mistake, for which alone corrections by reissue can be made.'' (262-263)

''A reissue is an amendment, and cannot be allowed unless the imperfections in the original patent arose with-

out fraud, and from inadvertence, accident or mistake. Rev. Stat. §4916. Hence the reissue cannot be permitted to enlarge the claims of the original patent by including matter once intentionally omitted. Acquiescence in the rejection of a claim; its withdrawal by amendment, either to save the application or to escape an interference; the acceptance of a patent containing limitations imposed by the Patent Office, which narrow the scope of the invention as at first described and claimed; are instances of such omission." (265)

"It is clear that the claim of this reissue is not covered by the original patent, and it appears that before the issue of the latter it was passed upon and rejected; was withdrawn and erased; an interference was dissolved upon condition of the amendment; and the issue of the original letters was predicated upon its abandonment. There is no room for the contention that there was any inadvertence, accident or mistake in the premises. Nor, in the light of these protracted proceedings in the Patent Office, can the applicant be permitted to treat the deliberate acts of his attorney as the result of inadvertence, accident or mistake. The repeated official decisions and orders, and the repeated efforts to maintain this claim without success, during this long struggle, indicate anything but negligence or inadvertence on the part of the solicitors employed." (265-266)

ELECTRIC GAS-LIGHTING COMPANY v. BOSTON ELECTRICAL COMPANY, 139 U. S. 481 [1891]

Interval—10 years

Motive of Reissue—To dominate interim apparatus.

Subject Matter—The patents dealt with electrical apparatus for lighting gas lamps. The original dis-

closure was impractical. The reissue added broader claims to dominate the subject matter of later successful inventions.

HELD

"The only difference of consequence between the original patent No. 130,770, and the reissue No. 9743, is in the claims, the text of the two specifications being almost substantially the same, and the drawings differing only as to scale." (482)

"The trivial verbal changes in the specification of the reissue show that there were no defects or insufficiencies in the specification of the original patent, which required correction; and that the sole object of the reissue was to multiply and alter the claims, which were increased in number from three to six." (487)

"Before the date of patent No. 130,770, numerous patents had been granted by the United States for electric gas-lighting apparatus; and the state of the art was such that no room was left for a pioneer or foundation patent for automatic electric gas-lighting apparatus." (492)

"It appears from those two patents that Tirrell then recognized the state of the art to be such that invention in automatic electric gas-lighting apparatus was limited to the specific mechanism described and claimed, or to its known equivalent." (493-494)

"• • • after the apparatus of No. 230,590 had been put into successful use by the defendant and by other persons who had acquired the right to use the invention from Pinkham, Tirrell was induced by the Franklin Electric Gas-Lighting Company to apply, in February, 1881, for the reissue of No. 130,770." (495)

"Apparatus like that shown in the drawings of No. 130,770 had not operated successfully, and had not been manufactured for several years prior to 1881." (495-496)

"The only motive which the officers of that company had in inducing Tirrell to apply for a reissue of No. 130,770, was to expand its claims so as to cover the invention for which No. 230,590 had been granted." (496)

"In the present case, the original patent was not inoperative or invalid by reason of a defective or insufficient description of the invention, for the text of the specification of the reissue, aside from the claims, is substantially the same as that of the original." (500-501)

"Moreover, the unexplained delay in applying for the reissue must be regarded as fatal to its claims." (501)

"If the claims of the reissue are limited, as they must be, to the specific mechanism described in the specification, it is very clear that the defendant's apparatus does not infringe. It is incapable of being used to light a series of burners. It opens the gas-valve by a single impulse, and closes it by a single impulse. No spark is produced until the gas-valve is fully opened. It has no switching mechanism, or any equivalent therefor, no ratchet-wheel and pawl, and no lever carrying the circuit-breaker. It has two magnets, two armatures, and two electric circuits, the magnets having no connection with each other, one of them being used solely for turning on and lighting the gas, and the other for turning it off, and no spark being produced in the latter operation. Nor has it any lever distinct from the armature; nor is the armature which operates to close the gas-valve ever in combination with the circuit-breaker." (503)

TOPLIFF v. TOPLIFF, 145 U. S. 156 [1892]

Interval—5 months

Motive of Reissue—To broaden claim without excessive delay.

Subject Matter—The patents dealt with carriage springs. The original narrowly claimed a combination of specific elements. It was reissued within four months and a second reissue applied for a month later claiming a combination of certain of the formerly claimed elements and a particular newly claimed element. The respective claims were:

Original	First Reissue	Second Reissue
"The arms CCC'C' arranged upon separate *rock*-rods BB' secured directly to the *front and rear axles* to cause both ends of *each spring* to yield simultaneously and in unison with each other, *and also to be laterally braced by said rock-rods*, as described."	"The arms CCC'C' arranged upon separate *connecting*-rods, BB' secured directly to the *hind axle* and *front bolster*, to cause both ends of *the side-springs* to yield simultaneously and in unison with each other, *in the manner shown* and described."	"2. The combination of the connecting-rod BB' provided with arms at their ends, with the half-elliptic springs AA', substantially as and for the purpose set forth."

The decision in this case reviews at length prior reissue cases and well summarizes the law.

HELD

"The second claim is to some extent a change of the claim of the first reissue. It omits the requirement that the connecting-rod shall be secured directly to the axle and bolster, so as to cause both ends of the side-springs to yield simultaneously, and introduces the half-elliptical springs AA' as a new element of the combination. Whether this be an enlargement of the original claim or not, it is for substantially the same invention, and in view of the fact that the reissue was applied for as soon as the mistake was discovered, and before any rights in favor of third

parties could be reasonably expected to have attached, or had in fact attached, we think this reissue is not open to the objections which have proved fatal to so many since the case of *Miller* v. *Brass Company*, 104 U. S. 350, was decided." (165)

"In the large number of cases which have come up to this court since that of *Mahn* v. *Harwood* was decided, in which reissues have been held to be invalid, it will be found that the opinion of the court was put upon the ground, either that the patentee had been guilty of inexcusable laches, usually of from four to sixteen years, or that circumstances had occurred since the granting of the original patent which made the reissue operate harshly or unjustly to the defendant in the case." (169)

"From this summary of the authorities it may be regarded as the settled rule of this court that the power to reissue may be exercised when the patent is inoperative by reason of the fact that the specification as originally drawn was defective or insufficient, or the claims were narrower than the actual invention of the patentee, provided the error has arisen from inadvertence or mistake, and the patentee is guilty of no fraud or deception; but that such reissues are subject to the following qualifications:

First. That it shall be for the same invention as the original patent, as such invention appears from the specification and claims of such original.

Second. That due diligence must be exercised in discovering the mistake in the original patent, and that, if it be sought for the purpose of enlarging the claim, the lapse of two years will ordinarily, though not always, be treated as evidence of an abandonment of the new matter to the public to the same extent that a failure by the inventor

to apply for a patent within two years from the public use or sale of his invention is regarded by the statute as conclusive evidence of an abandonment of the patent to the public.

Third. That this court will not review the decision of the Commissioner upon the question of inadvertence, accident or mistake, unless the matter is manifest from the record; but that the question whether the application was made within a reasonable time is, in most, if not in all such cases, a question of law for the court.

To hold that a patent can never be reissued for an enlarged claim would be not only to override the obvious intent of the statute, but would operate in many cases with great hardship upon the patentee. The specification and claims of a patent, particularly if the invention be at all complicated, constitute one of the most difficult legal instruments to draw with accuracy, and in view of the fact that valuable inventions are often placed in the hands of inexperienced persons to prepare such specifications and claims, it is no matter of surprise that the latter frequently fail to describe with requisite certainty the exact invention of the patentee, and err either in claiming that which the patentee had not in fact invented, or in omitting some element which was a valuable or essential part of his actual invention. Under such circumstances, it would be manifestly unjust to deny him the benefit of a reissue to secure to him his actual invention, provided it is evident that there has been a mistake and he has been guilty of no want of reasonable diligence in discovering it, and no third persons have in the meantime acquired the right to manufacture or sell what he had failed to claim. The object of the patent law is to secure to inventors a monopoly of what they have actually invented or discovered, and it ought not to be defeated by a too strict and technical adherence to the letter of the statute, or by the application of artificial rules of interpretation. The evidence

in this case shows that plaintiffs were conceded by manufacturers a monopoly of this invention; that defendant was the only one who had infringed their patents; and that he did not begin to manufacture the infringing device until 1882, six years after the second reissue was granted. In view of this and the fact that the second reissue was applied for within five months from the time the original patent was granted, and within thirty-seven days after the first reissue, and that it covers no more than the actual invention of the patentee, so far as the same is an improvement upon the Augur patent, we think it should be upheld." (170-172)

FREEMAN v. ASMUS, 145 U. S. 226 [1892]

Interval—1 year

Motive of Reissue—To claim an entirely different part of apparatus than the parts originally claimed.

Subject Matter—The patents dealt with blast furnaces. The original claimed a particular discharge block and the reissue claimed a particular furnace wall opening.

HELD

"It is apparent, from the description contained in the specification of the original patent, that Lürmann considered his invention to consist essentially of a removable slag-discharge piece, cast with numerous channels or pipes running through it, formed with a dovetail at its upper end fitted into the bottom of a stationary metallic plate connected with the furnace, and provided with channels or pipes so that water might flow through the slag-discharge piece and plate, conjointly or separately, that they might be cooled while the furnace was in operation." (236)

"The fundamental devices claimed by Lürmann as his improvements were (1) the metal plate C, provided with water channels; (2) the removable slag-discharge piece provided with water channels; and (3) the method of regulating the discharge of the slag by raising and lowering the temperature of the slag-discharge piece." (236-237)

"This testimony shows that, instead of desiring merely to remedy formal defects which appeared on the face of the papers, Asmus waited until experience and reasoning had shown him the broadest formula in which to express the claims of his patent so as to cover all possible modifications." (237)

"But the material point is the extension of the invention claimed, by the addition of claim 1 of the reissue, the words in which, 'substantially as set forth,' refer to the new matter in the reissue, that the slag is discharged 'through an opening cooled with water in such a manner that the tymp, or fore hearth, and the wall stone can be dispensed with.' The intention manifestly was to construe the first claim so as to cover any kind of blast furnace with a closed breast, having a slag-discharge opening cooled in any manner or to any extent by water. There is nothing in the original specification which indicates that any such claim was intended to be made in the original patent. On the contrary, the whole purport of that specification shows that it was intended to claim only a slag-discharge piece or cinder block constructed and attached in a specific manner, as is set forth in the statement of the attorneys of Asmus, accompanying his application for the reissue." (239)

"We are of opinion that the present reissue is invalid, so far as the first claim of it is concerned, because it is not

for the same invention as the original patent, and is, therefore, within the express exception of the statute, (Act of July 4, 1836, c. 357, §13, 5 Stat. 122). There is nothing inconsistent with the foregoing views, in our decision in *Topliff* v. *Topliff, ante,* 156." (241)

HUBER v. NELSON MANUFACTURING Co., 148 U. S. 270 [1893]

Interval—1 year

Motive of Reissue—To dominate interim marketed apparatus.

Subject Matter—The patents dealt with flushing chambers. The original narrowly claimed combinations of six elements. The reissue claimed a sub-combination omitting an element which the original had made essential to operativeness and novelty.

HELD

"Being an old device, he could not claim the injector, independently, or otherwise than in combination with other devices forming a part of his improved sanitary water-closet." (282)

"The view taken by Judge Thayer was that the sole purpose of Boyle, in asking for a reissue, was to eliminate the 'flushing-chamber,' as a constituent element of the combination covered by certain claims of the original patent to Boyle, particularly of claim 1, and to obtain a patent for a flushing apparatus like that described in said claim 1, less the flushing-chamber, and so claim 2 of the reissue was granted in the terms above set forth, omitting the flushing-chamber from the combination. It was omitted also from claim 1 of the reissue. The effect of this was to expand the claims of the original patent, because they had

been limited by including the 'flushing-chamber' as an element of the combination." (284)

"* * * that it was manifest from other statements made by Fraser in the course of his testimony, that in his opinion a flushing apparatus minus the flushing-chamber with its attendant devices for securing an after-wash would be practically useless; that some provisions for refilling the bowl after the injector had ceased to act was essential to the successful operation of the flushing apparatus or water-closet, considered as a whole; and that, in drafting the several claims of the original patent, he intentionally and, as it would seem, with great care, included the flushing-chamber, for the reason that it was one of the essential parts of the flushing apparatus, without which the latter would not be serviceable." (287)

"The opinion further states that the testimony showed, to the entire satisfaction of the court, that Fraser was right in supposing that Boyle's flushing apparatus, without the flushing-chamber would be incomplete and therefore practically valueless; * * *" (288)

"The opinion of the Circuit Court further said that the testimony did not tend to establish that either Boyle or Frazer acted so inadvertently or under such misapprehension of either law or fact, when the claims of the original patent were formulated, as to justify a reissue of the patent; that it was obvious to them, as to any one, that the injector would perform its function as well with a single tank as with a tank and flushing-chamber combined; that both of them believed that a water-closet constructed according to Boyle's design, but without provision for an after-wash, would be valueless in the market; that in that belief they were right; that Boyle had discovered no method of producing an after-wash automatically by using

a single water-tank, and hence both he and Fraser regarded the flushing-chamber as one of the essential features of the flushing apparatus intended to be manufactured, and accordingly claimed it industriously in all of the important claims; that even though they claimed the injector in combination with a part which was non-essential to its operation, and thereby limited the claim, yet they did so in pursuance of a well-defined purpose, not based upon a misconception of matters of fact or ignorance of law, so far as the records before the Commissioner of Patents or the proof in this case showed; that the injector was an old device when Boyle adopted it; that it could be claimed only in combination with other parts which would together produce a new result or effect, or constitute a new machine; * * *" (289)

"The opinion further observed that if the injector were new with Boyle, and had not been claimed in the original patent, it might be proper to interpret the law liberally in favor of Boyle, to enable him to realize the full benefit of his invention; that an injector is an old device, and Boyle merely adopted it and applied it to a new use; and that he ought to be limited to that combination in which he deliberately placed and claimed it.

The conclusion of the opinion was that the reissue, being granted merely to enlarge the claims, could not be sustained, citing *Burr* v. *Duryee*, 1 Wa., 531, and *Gill* v. *Wells*, 22 Wall. 1; that the failure to claim the particular combination not claimed in the original patent but claimed in the reissue, was not due to any such inadvertence or mistake as would authorize the claiming of it in the reissue; and that the failure to claim such combination originally occurred under such circumstances, and was accompanied with such full knowledge of all material facts, as to amount to an abandonment of that particular combination to the public.

We are unanimously of opinion that these views of the Circuit Court are sound; and that it is unnecessary to consider the point made by the defendant that the reissue was invalid because it lacked novelty and invention. It is not contended that the defendant has infringed any other claims of the reissue than claims 1 and 2; and we think it entirely clear that the defendant has not infringed any of the claims of the original patent. The defendant had no flushing-chamber in any flushing apparatus made by it; and such flushing-chamber was an essential element in the specification and drawings of the original patent, and was one of the necessary elements in each of the six claims of the original patent, as made. It is impossible to examine the drawings of the original patent and see that the flushing-chamber could be dispensed with in the structure." (290-291)

"In the specification of the original patent, the flushing-chamber had been made an essential element in each of the six claims." (291-292)

"It was not until Boyle obtained knowledge of the Hanson patent that he conceived the idea of claiming such a construction as had been patented to Hanson. Then, and not until then, he announced the idea that it was of value to do away with the flushing-chamber, although the specification of his original patent, in its text and drawings and claims, emphasized the importance of the flushing-chamber as an element in every one of his combinations." (292)

LEGGETT v. STANDARD OIL COMPANY, 149 U. S. 287 [1893]

Interval—4 months

Motive of Reissue—To claim article which the original had disclaimed.

Subject Matter—The original patent was directed to a process of lining a barrel with semi-finished glue. The reissue claimed also the thus treated article.

HELD

"This invention [the original patent] has nothing to do with the glue-lined barrel as an article of manufacture, but relates particularly to a new and inexpensive process of constructing a glue-lined barrel, cask, etc." (289)

"The opinion of the court below is reported in 38 Fed. Rep. 842, and the ground upon which the decision proceeded was that there was a lack of patentable invention in the thing patented.

We are of opinion that there is no error in the judgment of the court below for various reasons. In the first place, the second claim of the reissue, secured, as it was, by important changes in the specification of the original patent, was a manifest enlargement or broadening of the patent. It is not pretended that there was any mistake, accident, or inadvertence in either the specification or the claim of the original patent such as would render it void or inoperative, and warrant the granting of a reissue thereof with an additional and enlarged claim." (292)

"It is shown by the complainant's own testimony that he procured the reissue for the purpose of having it cover barrels so as to make the defendant an infringer." (292)

"This second claim of the reissue, being a manifest attempt to broaden the original patent, cannot, in view of the amended specification on which it was based or procured, be held to cover a glue-lined barrel as an article of manufacture, which was distinctly disclaimed by the original specification." (293)

"In addition to these difficulties in the way of the complainant succeeding in this case, his alleged invention was clearly anticipated by the prior use and sale of liquid glue, or size, used for various purposes, including that of coating barrels." (294-295)

"It being thus clearly established that the use of liquid glue was well known to glue manufacturers and oil refiners, and had been actually applied in the very way and for the very purposes described by the complainant, long before the date of his alleged invention, it is too clear for discussion that he could have no valid patent which would cover a process for using liquid glue for coating or sizing purposes as a new discovery or invention; and our conclusion, therefore, is that the decree of the court below was clearly correct, and should be *Affirmed.*" (297)

CORBIN CABINET LOCK COMPANY v.
EAGLE LOCK COMPANY, 150 U. S. 38 [1893]

Interval—2 years

Matter of Reissue—To cover interim apparatus.

Subject Matter—The original patent claimed a particular construction of cabinet lock. The reissue claimed a different combination of a lock and special mortise.

HELD

"The specification and claim of the original patent, as allowed, described and covered a lock *per se* of a special construction, and did not extend to or include anything in combination therewith.

In the application for reissue, filed April 28, 1883, the original specification was amended in two material respects. The new matter consisted of a statement describ-

ing how a mortise should be formed, and how the lock is to be combined therewith, so as to be held laterally therein, as follows: 'By means of the portions of the walls of the mortise which are in front of the locking-plate G' and in the rear of the front-plate of the lock.' And there was also added this further statement: 'It will thus be seen that the lock is prevented from lateral displacement by the projections upon the back-plate in combination with the corresponding shape of the mortise, and that it is prevented from vertical displacement by the thin strip *m* and bent part G'.' " (41)

"It is perfectly manifest that the new matter in the reissue specification was inserted to lay the foundation for either changing the original claim, or the patent covered thereby; or for the purpose of expanding that claim, so as to make it cover substantially what had been rejected on the original application. An examination of the proceedings in the Patent Office, in connection with the original application, and the claim of the original patent, renders it perfectly obvious that the first claim of the reissue is not for the lock as such, but is for a combination of a lock with a mortise, and in this respect it is for a different invention from that described in the single claim of the original patent, which covered only a lock of definite description. The first claim of the reissue clearly includes, as an element of the combination therein described, a peculiarly constructed mortise to receive the lock. This element the original patent does not indicate as being any part of the invention of the patentee. As already stated, the claim of the original patent is for a lock as such, while the first claim of the reissue is for a combination of that lock with something not claimed as an element in the original patent, viz., a peculiarly shaped mortise. This was a departure from the original claim not warranted by anything appearing in the original specification." (41-42)

DUNHAM v. DENNISON MFG. CO., 154 U. S. 103 [1894]

Interval—1 year

Motive of Reissue—Enlargement to cover interim developments.

Subject Matter—The original disclosure and claim was limited to an end opening envelope to cover the entire side of the envelope. The reissue disclosure and claim was enlarged to cover a combined tag envelope with the flap of the latter of any size and shape.

HELD

"After the defendant had made envelopes with a short flap of semi-circular shape and covering little more than the opening of the envelope, (which, it is admitted, did not infringe the plaintiff's patent as originally issued), the plaintiff obtained a reissue, enlarging the claims, and altering the specification throughout, so as to include an envelope with a flap of any size or shape, and to make the invention consist, not, as in the leading words of the description in the original patent, of 'an envelope with an end flap covering its side,' but in 'a tag provided with means for attaching it to the merchandise, and with an envelope or pocket to receive a bill or invoice of the merchandise.' The words of the description in the original patent were neither technical nor complicated; but they were of the simplest kind, and their meaning and scope could not have been misunderstood by any one who read them with the slightest attention, least of all by the patentee. To uphold such a reissue under such circumstances would be to grant a new and distinct privilege to the patentee at the expense of innocent parties, * * *" (110-111)

OLIN v. TIMKEN, 155 U. S. 141 [1894]

Interval—6 years

Motive of Reissue—To dominate interim marketed construction.

Subject Matter—The patents dealt with vehicle springs. The original narrowly claimed a combination of crossing springs pivoted together at the crossing point. The reissue eliminated the requirement for any connection at the crossing point.

HELD

"As the patent originally stood, the connection of the cross-springs was an essential element of the claim, but, if the reissue were valid, the bolt coupling the two springs together at their centre and forming an articulated joint would in effect be eliminated. The application for reissue was not filed until November 27, 1880, while the original patent was dated December 1, 1874, and the reissue was thus made by expansion to cover structures in public and common use between those two dates.

Huber v. *Nelson Manufacturing Co.*, 148 U. S. 270, is much in point. There one Boyle obtained a patent for a sanitary closet, including, as an essential element of the claim, a flushing chamber, and subsequently applied for a reissue for the purpose of eliminating that chamber. But this; it was held, could not be done.

The object of the original Tilton invention was declared to be to provide carriages or other vehicles with springs to prevent the rocking motion of the body supported thereon, and it was stated in the specification: 'It is well known that elliptic or semi-elliptic springs secured to the centre of the cross-bar of the carriage body will permit the same

to rock from side to side. It is objectionable for various reasons.' It was proposed to remedy this by taking springs of the form shown, which might be properly termed sections of semi-elliptic springs, and arranging them to cross each other on the centre of the cross-bar upon which the body was placed, each spring being provided with a socket at the crossing point and a pivot bolt passing through both springs, secured by a nut, this coupling preventing them from moving independently of each other. In the first claim the words were used, 'hinged together at their crossing point,' in the second claim, 'two leaf-springs, each provided with a socket at their crossing point;' in the third claim, 'the combination of two springs side by side, and connected together, with the side sills and cross-bar, for supporting the body in a horizontal position;' while the fourth claim was for the reenforcing plate and connected cross-springs.

Appellee's contention that the connection of the crossed springs of the third and fourth claims is a connection by means of the reenforcing plate and its flanges, which, the specification says, were intended to serve as bearing points for the ends of the springs, described in the fourth claim as a separate element in combination with the body-supporting bar and the connected cross-springs, requires no comment.

The new fifth claim omits the crossing connection altogether and covers matter recognized as old in the original patent, and claims three and four, if broadly construed in connection with the new matter introduced in the specification, render the central connection non-essential, since it might be omitted, if preferred. There is no basis for the theory of inadvertence, accident, or mistake, and the reissue cannot be sustained." (147-148)

EBY v. KING, 158 U. S. 366 [1895]

Interval—4 years

Motive of Reissue—Alteration of disclosure and enlargement of claim to dominate interim marketed device.

Subject Matter—The original narrowly claimed a subcombination of mechanical elements in a cob carrier for corn shellers. The reissue introduced a new feature and broadly claimed any movable independent cob carrier comprising a specified particular combination of elements.

HELD

"Meantime, however, defendant had, for more than two years preceding the application for the reissue, been manufacturing and selling cob-carriers substantially the same in construction as that shown in the alleged infringing device. It also appears that plaintiff was unable to obtain royalties, or sell licenses under his original patent, by reason of his claims being too narrow; but that since he had succeeded in having the patent reissued with broadened claims, other manufacturers had submitted to his demand for royalties.

Under the rulings of this court, it is clear that this reissue cannot be supported. Not only was there no claim of a defective or insufficient specification; none that the patentee had claimed as his own invention more than he had a right to claim as new; none of inadvertence, accident, or mistake; but four years after the original patent was issued, the patentee attempts to secure a reissue, with claims broadened for the purpose of covering that which is presumed to have been once abandoned to the public. All that has ever been said by this court in restraint of the practice of reissuing patents applies with full force to this case." (372-373)

"But, even if the patentee were able to fall back upon the original patent, counsel for the appellant, as well as his expert, admits that the combination described in the first claim of such patent was anticipated by certain patents to Brinsmead and Bryan, and that described in the second claim was also anticipated by a patent to one Nimbs. Assuming this to be so, it was clearly incompetent for the patentee to abandon these claims *in toto* and recontruct his patent upon a different theory, in order to make it salable, or to hold as infringers other manufacturers who, in the meantime, had entered the field, relying upon his original patent as representing what he claimed to have invented and to be his own." (374)

ABERCROMBIE & FITCH COMPANY, ET AL. v. BALDWIN, ET AL., 245 U. S. 198 [1917]

Interval—7 years

Motive of Reissue—The suit in the Seventh Circuit on the original patent resulted in a holding of non-infringement. The reissue patent was obtained and a suit on it in the Third Circuit resulted in holding that the claim was broader than the original and that the reissue was, therefore, void. A second suit on the reissue in the Second Circuit resulted in a holding that the reissue patent was valid and was infringed by a device like that which the Seventh Circuit held not to infringe the original patent.

Certiorari was granted on conflict of decisions.

Subject Matter—The patents dealt with a lamp to generate and burn acetylene, important elements of which included a tube extending from a water compartment to a calcium carbide compartment and a stirring rod extending through the tube with an end extending into the carbide. As to these the reissue made two changes

from the original; first, that the tube was always embedded in the carbide and second, additional description in the specification as follows:

> "It will be understood from what has been said that the function of the stirrer is to break up, pierce, or disturb the particles of the slaked carbid mass, which, when the lamp is in use, forms at the delivery end of the tube. This slaked carbid mass tends to solidify, and either shuts the water off altogether or restricts it so that less water is delivered from the water tube than the lamp demands for efficient operation. As it is sufficient, under certain circumstances, to insure the requisite flow of water by so manipulating the stirrer as to pierce, break up, or loosen the slaked carbid mass immediately around or at the mouth of the tube, it is obvious that the stirrer need not always be formed with a bent end, or so as to extend radially from the mouth of the tube."

HELD

"The controversy is, therefore, brought to a consideration of the original patent as added to or developed by the reissue. And their comparison centers in a water-feeding duct or tube and its restriction by means of a wire or rod and the shape and use of the rod to pierce or stir the carbide. In the original patent, as we have seen, it was said that the invented method for securing a proper feed (flow of the water to the carbide) without certain specific objectionable features was 'to make the bore of the duct of comparatively large size and then restrict it by means of a wire or rod preferably centrally located therein to leave a channel of the proper size.' In the reissue, after the words 'comparatively large size', it was added—'extend the tube which forms the duct downward so that its end will be always embedded in the carbid.' In other

words, the tube is explicitly described as extending to and its end embedded in the carbide, and this, it is contended, was an enlargement of the original patent.

The contention is untenable if there was in the original patent an implication of such length and termination of the tube, and we think there was." (205-206)

"There is nothing in this but what was clearly implied in the original, except the shape of the stirrer. In the original it is described and represented as bent. In the re-issue it is stated to be obvious that the stirrer need not always be bent 'or extend radially from the mouth of the tube.'

We are unable to assign to this the extent of alteration that counsel do, nor do we think it necessary to rehearse the details of their argument. We have given it attention and the cases it cites, especially the decision and reasoning of the Circuit Court of Appeals for the Third Circuit in *Grier Bros. Co.* v. *Baldwin*, 219 Fed. Rep. 735, but we are constrained to a different conclusion. Indeed, we are of opinion that the original patent did not need the exposition of the re-issue. It exhibited an invention of merit, certainly one entitled to invoke the doctrine of equivalents. *Paper Bag Patent Case*, 210 U. S. 405. Baldwin, the patentee, complied with the statute (§4888, Rev. Stats.) by explaining the principle of his invention and the mode of putting it to practical use; there was a clear exposition of the principle and the instruments of its use were defined and their purpose and manner of operation. It left nothing in either for further experiment or contrivance." (207)

"Whether the rod was bent or made straight was unimportant. In either form it removed the slake and secured the continuous operation of the water and carbide and through them the formation of the gas and its illuminating purpose. One or the other might be better, according

to the extent of the dispersion required, and one naturally suggested the other." (208)

"We do not think the case calls for extended discussion. It is best considered in broad outline. The scope and merit of the patents are of instant and assured impression, and to the attempt to defeat or limit their invention by the state of the prior art we adduce the discussion and reasoning of the opinion of the lower courts, which we approve." (208)

"The denial of infringement is also easily disposed of. Indeed, it has been in effect disposed of. It is based on the contention that the stirrer is an essential of plaintiff's lamp and that a stirrer is absent from defendant's lamp, which is in all other particulars, as far as this case is concerned, similar to the plaintiff's lamp. To the contention of defendants, therefore, we cannot assent. There is a stirrer in both, and its form as we have seen, is not of the essence of the invention." (209)

VANDENBURGH v. TRUSCON CO., 261 U. S. 6 [1923]

Interval—9½ years

Motive of Reissue—To alter subject matter claimed to entrap materially different interim devices.

Subject Matter—The patents dealt with reinforcing bars for strengthening concrete.

HELD

"The preferred form of Vandenburgh for the engagement between his reinforcing bar and the spiral loops of his truss arrangement is by a kerf or cut in the edge of bar inclined away from its center in which the coil rod is

placed and held therein by an integral spur forced downward upon the coil when inserted, which permanently retains it in position. The defendant has a rectangular cut in the edge of the T spacer or upright and retains the spiral rod in it by peening or hammering down the edges of the cut so as to keep the rod from slipping out, but leaving play enough to permit the collapsing of the spiral and shipment in its collapsed form. Others had adopted a similar form of engagement. Observing this, Vandenburgh who had not used or exploited his original patent in any way, went back to the patent office and secured a reissue in which he was permitted to broaden his first and second claims with respect to the kerfs and spurs so as to change the word 'rigidly' used in the original claim to 'permanently.' Having done this, he proceeded to sue in the second, third and sixth circuits persons using what he insisted were equivalents of his form of engagement in their column hooping reinforcement of concrete columns. All the courts, and there are six of them, have held these changed claims of the reissued patent to be void and to give him no right to claim infringement in the collapsible feature of the column hooping. The original specifications leave no doubt that the patentee used the word 'rigidly' deliberately and properly because his truss, as he protrayed it, required rigid connection between the spiral loops and the main reinforcing bar. His making his form of engagement loose was an afterthought to catch makers who had not been advised in his specifications that there was anything collapsible in his truss formation. The reissue as to the first two claims was in the teeth of the admonitions of this Court speaking through Mr. Justice Bradley in *Miller* v. *Brass Co.*, 104 U. S. 350. They are therefore void." (13-14)

"It is clear to us that Vandenburgh having secured a patent for a truss form of reinforcement and finding it

unworkable, for it never has been adopted in the trade or in any structure, is through reissue seeking to expand the paper combination he claims into a field in which it does not belong." (15)

KELLER v. ADAMS-CAMPBELL Co., 264 U. S. 314 [1924]

Interval—6 months

Motive of Reissue—To broaden claims

Subject Matter—The patents were for auxiliary wing type windshields for automobiles in which clamps gripped the ends of the glass. In the defendant's device these clamps were held through perforations in the glass near the center and not at the ends.

The case was decided on non-infringement but the Court recognized the propriety of a broadened reissue.

HELD

"This was a suit to enjoin the infringement of a patent for an improvement in auxiliary windshields for automobiles. It was brought on a reissued patent. The reissue was granted on the ground that the original patent was inoperative to protect the real invention due to defective and insufficient and too narrow claims, all of which arose through inadvertence and mistake due to misunderstanding between the inventor and his solicitor." (315)

"That a reissued patent enlarging claims of the original, although not specifically mentioned in §4916, Rev. Stats., is authorized by that section, when the failure to claim the larger claims justified by the actual invention was due to inadvertence, accident or mistake, is settled by the decision of this Court in *Topliff* v. *Topliff*, 145 U. S. 156, and other cases." (317)

SONTAG CHAIN STORES CO., LTD. v.
NATIONAL NUT COMPANY, 310 U. S. 281 [1940]

Interval—1 year, 7 months

Motive of Reissue—To enlarge claims for dominating interim marketed machine.

Subject Matter—The case reached the Court by certiorari as to a defense of invalidity on account of laches and as to a defense of intervening rights. The decision passed only on the latter question, though the Court recognized the propriety of broadened reissues under proper conditions.

HELD

"Respondent was moved to obtain the reissue by petitioner's use of the accused machine." (282)

"In the case under consideration, the patentee might have included in the application for the original patent, claims broad enough to embrace petitioner's accused machine, but did not. This 'gave the public to understand' that whatever was not claimed 'did not come within his patent and might rightfully be made by anyone.' The enlarged claims were presented with knowledge of the accused machine and definite purpose to include it.

Recapture within two years of what a patentee dedicates to the public through omission is permissible under specified conditions, but not, we think, 'at the expense of innocent parties.'"

IN THE

Supreme Court of the United States

OCTOBER TERM, 1941

No. 680

U. S. INDUSTRIAL CHEMICALS, INC.,
Petitioner,

vs.

CARBIDE AND CARBON CHEMICALS CORPORATION,
Respondent.

APPENDIX II TO BRIEF FOR RESPONDENT

Post Printing Company, Inc., 80 Lafayette Street, New York, N. Y.

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APPENDIX II

DIGEST OF DECISIONS ON INTERVENING RIGHTS

RESUME OF THE DECISIONS

The Reissue Statute has no expressed provision for the defense commonly called "Intervening Rights". The statute states

> "Every patent so reissued, together with the corrected specification, shall have the same effect and operation in law, on the trial of all actions for causes thereafter arising, as if the same had been originally filed in such corrected form; • • • "

The earliest decision of this Court rejected pleas of reissue infringers for immunity to continue manufacture and sale which had begun prior to the application for the reissue and without infringing the original patent, *Grant* v. *Raymond*, 31 U. S. 217 [1832].

In the case of *Abercrombie & Fitch Company et al.* v. *Baldwin et al.*, 245 U. S. 198, [1917], the defense of intervening rights, as such, was first dealt with by this Court, and there denied on the particular facts involved in affirmance of the District Court and the Circuit Court of Appeals for the Second Circuit.

In the still later case of *Keller* v. *Adams-Campbell*, 264 U. S. 314, [1924] this Court dismissed a writ of certiorari as improvidently granted but commented on the defense of

intervening rights as applied by the various Circuit Courts of Appeals in

Crown Cork & Seal Co. of Baltimore City v. *Aluminum Stopper Co. of Baltimore City et al.*, 108 Fed. 845

General Electric Co. v. *Richmond Street & Interurban Ry. Co.*, 178 Fed. 84

A. D. Howe Mach. Co. v. *Coffield Motor Washer Co.*, 197 Fed. 541

Autopiano Co. v. *American Player Action Co.*, 222 Fed. 276

American Automotoneer Co. v. *Porter*, 232 Fed. 456

In the latest case of *Sontag Chain Stores Co., Ltd.* v. *National Nut Company*, 310 U. S. 281, [1940] this Court reversed the decision of the court below which had rejected the defense of intervening rights on particular facts and after reference to

Ashley v. *Samuel C. Tatum Co.*, 240 Fed. 979

Moto Meter Gauge & Equipment Corp. v. *E. A. Laboratories, Inc.*, 55 F. (2d) 936

Christman v. *New York Air Brake Co.*, 1 F. Supp. 211

Wooster v. *Handy*, 21 Fed. 51

this Court quoted with approval from *Ashland Fire Brick Co.* v. *General Refractories Co.*, 27 F. (2d) 744.

During the hundred years between *Grant* v. *Raymond* and the *Sontag* case most of the reissue cases decided by this Court involved facts where the reissue patent had been motivated by the patentee's belated knowledge of independently conceived and materially different subject matter which had gone into public use and was free from

infringement of his original patent and by the patentee's belated effort to entrap such subject matter by broadened reissue claims. The decisions in those numerous cases turned on issues of novelty, or scope, or laches in the light of such circumstances, as appears from the quotations collected in Appendix I to Brief for Respondent. This Court itself recognized in *Topliff* v. *Topliff*, 145 U. S. 156, as to those reissues which had been held invalid since the *Mahn* v. *Harwood* case reported in 112 U. S. 354, that

> "it will be found that the opinion of the court was put upon the ground, either that the patentee had been guilty of inexcusable laches, usually of from four to sixteen years, or that circumstances had occurred since the granting of the original patent which made the reissue operate harshly or unjustly to the defendant in the case."

The doctrine of intervening rights, the equity considerations on which it firmly rests, and the extent of its application by this Court and by the courts of various circuits, are fully exemplified in the decisions in the *Abercrombie & Fitch* case, the *Keller* case, and the *Sontag* case above cited, and the lower court decisions there referred to, from all of which the pertinent facts and conclusions are excerpted *infra*. Examination of these is believed to indicate a less unsettled character of the question than might have been expected to be found in advance of more numerous decisions on the point by this Court.

I.

Through all of the decisions, the controlling test is recognized and applied that a reissue patentee who has acted in good faith prevails against a defendant who has acted in

less good faith, on the one hand; and a defendant who has acted in good faith prevails against a reissue patentee who has acted in less good faith, on the other hand.

II.

It is likewise the consistent and established rule (to which we believe there has been no exception) that the immunity to be safeguarded the possessor of intervening rights is an immunity for continuing manufacture, use or sale after the grant of the reissue of *actual manufacture, use or sale* which existed in good faith and without infringing liability between the date of the grant of the original patent and the date of the application for the reissue patent.

III.

In all these decisions there runs the consistent thread that the bona fide manufacture, use or sale, which intervened and the continuance of which cannot be interfered with by the reissue patentee, was a consummated, open, industrial adjunct of defendant's business. No distinction has necessarily been drawn with reference to the mere magnitude of the intervening operations. On the other hand, uniform emphasis has been placed on the effectuated and commercial character of such operations.

Manifestly, mental reflection, however deliberate, and mere experimentation, however studious, about academically free *possibilities* after the date of the original patent and before the date of the application for its reissue cannot alone afford a supportable basis for an immunity with respect to a commercial realization begun and consummated only after the filing date of the application for the reissue. To hold otherwise would seem to open the door to fraud by the unscrupulous infringer.

IV.

In the case of original patents, the Court may take judicial notice of the fact that the applications therefor are frequently pending for long intervals and always pending in secrecy, and that as an inevitable consequence the relevant industry moves forward by spending thought, effort and money subject to the risk of liability from future patents then inchoate. That risk has not been unduly burdensome to American industry. The analogous risk with respect to reissue patents is much less. In the first place, the reissue patent must always be for the "same invention" as the original, which is a public document. In the second place, in the case of broadened reissues (where alone the analogous risk occurs) the application for the reissue must have heretofore been filed within two years of the grant of the original under the settled law, and hereafter by analogy due to the change in the statute within one year of the date of the original patent. In the third place, the mere number of reissue patents is trifling in comparison with that of original patents. In the fourth place, in contradistinction to the secrecy of the pendency of original applications, the fact of pendency of reissue applications is a matter of available public record under the rules of the Patent Office.

V.

The statutory provision for reissuance of defective patents, properly qualified, is an integral, vital, though minor, part of the patent system.

The law with respect to the issues of "same invention" and "intervening rights" is crystallized in the language of District Judge Mayer in *Baldwin* v. *Abercrombie & Fitch Co.*, 227 Fed. 455, (affirmed by this Court 245 U. S. 198):

> "Reissues often present troublesome questions, but the ultimate test, I think, is good faith." (458)

THE DECISIONS ON INTERVENING RIGHTS

ABERCROMBIE & FITCH CO. v. BALDWIN, 245 U. S. 198 [1917]

Interval—7 years

Motive of Reissue—The suit in the Seventh Circuit on the original patent resulted in a holding of non-infringement. The reissue patent was obtained and a suit on it in the Third Circuit resulted in holding that the claim was broader than the original and that the reissue was void. A second suit on the reissue in the Second Circuit resulted in a holding that the reissue patent was valid and was infringed by a device like that which the Seventh Circuit had held not to infringe the original patent.

Certiorari was granted on conflict of decisions.

Subject Matter—the chronology of facts was as follows:

Original applied for....	July 15, 1903	
Original granted	May 22, 1906	
Original held valid and infringed	Apr. 1911	(By D.C.)
Defendant began selling its lamps	July 1911	
Original held valid but not infringed	Apr. 23, 1912	(By C.C.A. 7)
Reissue applied for....	Feb. 5, 1913	
Reissue granted	Mar. 11, 1913	
Reissue held invalid....	Jan. 22, 1915	(By C.C.A. 3)
Reissue held valid and infringed	Feb. 6, 1915	(By D.C., N.Y.)
Reissue held valid and infringed	Nov. 9, 1915	(By C.C.A. 2)

Commercial sale of accused lamps began five years after original patent issued and one and a half years prior to application for reissue.

HELD

"To the contention that the Justrite Company, the manufacturing defendant, acquired rights before the re-issue we again may oppose the reasoning and conclusion of District Judge Mayer and their affirmance by the Circuit Court of Appeals. The learned judge said: 'It will be remembered that this company entered the field with its lamp at a time when the validity and scope of the Baldwin patent were still unquestioned and when after some five years of capable effort, the Baldwin lamp had created an extensive market. The Justrite Company took its chances, and, in view of the necessities of the situation, it is relieved of all accountability for the period prior to the granting of the reissue patent; but when the reissue was granted the Justrite Company again took its chances.

By the reissuance of the patent, the patentee loses all in the way of an accounting under the original patent, but the dominant purpose of the reissue statute was to save to the inventor the future remaining after the reissue.

I see nothing in the course of plaintiffs or defendants which would allow a court of equity to conclude that defendants are to be relieved because of intervening rights.'" (209-210)

KELLER v. ADAMS-CAMPBELL CO., 264 U. S. 314 [1924]

Interval—6 months

Subject Matter—The original patent was issued in Nov. 1918. Defect was discovered April 1, 1919. Reissue was applied for May 22, 1919, and the reissue patent granted July 20, 1920.

HELD

"A. F. Kipper, who was the active person among the defendants in designing and promoting the manufacture of the windshield charged to be an infringement, was familiar with the device, the specifications and claims of Keller. He conceived of his device in December of 1918, made some models of it in February of 1919, and in association with one Dick Smith, got up some experimental dies and tools for its manufacture and sale in April and May of that year. Kipper was an employee of Adams-Campbell Company and that firm in August of 1919 made a contract with Kipper to go into the business of making and selling his product.

The suit for infringement was begun July 1, 1921." (315-316)

"We granted certiorari upon the allegation of the petition, not denied by opposing counsel, that the sole question was

whether one who makes and sells articles not covered by the claims of an original patent, but embraced by the enlarged claims of a subsequent valid reissue, applied for within seven months after the original was granted, has intervening rights such that he is not only immune from liability for what he has made and sold, but enjoys an irrevocable and permanent license to continue to make and sell without restriction.

The extent of the operation of the estoppel creating intervening rights in such a case presents a question not free from difficulty. That a reissued patent enlarging claims of the original, although not specifically mentioned in §4916, Rev. Stats., is authorized by that section, when the failure to claim the larger claims justified by the actual invention was due to inadvertence, accident or mistake, is settled by the decision of this Court in *Topliff* v. *Topliff*, 145 U. S. 156, and other cases. That case also recognizes that one who, pending the application and granting of the reissue, manufactures and sells articles which infringe the reissued patent may be protected on principles of estoppel from the literal application of §4916, Rev. Stats., which makes the operation of the reissue relate to the date of the original patent. In *Abercrombie & Fitch Co.* v. *Baldwin*, 245 U. S. 198, a change, in the reissue, of the language of an original claim made it cover not only a bent pipe as shown, but a straight pipe as well, where the substance of the invention included both, and it was held that the intervening rights of immunity of the infringer did not extend beyond the date of the reissue. It is insisted, however, that the *Fitch Case* was not one of an enlarged claim, or at any rate that a reissue was unnecessary because the original claim would have sufficed. The views of the Circuit Court of Appeals on the general subject of the scope of intervening rights are not entirely easy to reconcile. *Crown Cork & Seal Co.* v. *Aluminum Stopper Co.*, 108 Fed. 845; *General Electric Co.* v. *Richmond Ry. Co.*, 178 Fed. 84; *A. D. Howe Mach. Co.* v. *Coffield Motor Washer Co.*, 197 Fed. 541; *Auto-*

piano Co. v. *American Player Action Co.*, 222 Fed. 276; *American Automotoneer Co.* v. *Porter*, 232 Fed. 456. The question, if it were really before us, would be one sufficiently important therefore to justify our consideration of it on certiorari." (317-318)

"• • • what the courts [below] really held was that the defendants were manufacturing a different invention from that of the plaintiffs, and so could not and did not infringe. Such an ordinary patent case with the usual issues of invention, breadth of claims and non-infringement, this Court will not bring here by certiorari unless it be necessary to reconcile decisions of Circuit Courts of Appeals on the same patent. We therefore find ourselves mistaken in assuming that an important issue of general patent law under §4916, Rev. Stats., is here involved. The result is that an order must be entered dismissing the writ of certiorari as improvidently granted at the costs of the petitioner." (319-320)

SONTAG CHAIN STORES CO., LTD. v. NATIONAL NUT COMPANY, 310 U. S. 281 [1940]

Interval—1 year, 7 months

Subject Matter—The chronology of facts was as follows:

Original patent issued	May 15, 1934
Manufacture of accused machine began	Aug. 1934
Defendant's accused use began	Apr. 1, 1935
Notice of infringement of the original patent	Oct. 8, 1935
Suit began on original patent	Oct. 19, 1935
Defendant denied infringement	Nov. 22, 1935
Application for reissue filed	Jan. 15, 1936
Reissue granted	June 30, 1936
Suit begun on reissue	Jan. 26, 1937

HELD

"Kohler's patent—No. 1,958,400—with four narrow claims, issued May 15, 1934.

Petitioner procured and began to use the machine here accused about April 1, 1935. It first obtained actual knowledge of the original patent October 8, 1935 when notice of infringement was received. Nothing shows earlier knowledge by the manufacturer who began to make and sell like machines not later than August 1934.

By suit filed in the District Court, October 19, 1935, respondent charged petitioner with infringing the original patent, and asked appropriate relief. Infringement was denied by answer, November 22, 1935.

January 15, 1936 respondent applied for and on June 30, 1936 obtained a reissue patent—No. 20,024—with seventeen claims. The first four were identical with the original ones; thirteen of broader scope cover petitioner's machine. Respondent was moved to obtain the reissue by petitioner's use of the accused machine." (282)

"For present purposes we assume, without deciding, correctness of the conclusion that the reissue patent was valid and infringed, and upon that assumption, we come to consider the effect of the enlarged claims upon petitioner's machine, lawfully manufactured and operated prior to their inception. There is nothing to show dishonesty, bad faith, or deceptive intention upon petitioner's part." (285)

"Recapture within two years of what a patentee dedicates to the public through omission is permissible under specified conditions, but not, we think, 'at the expense of innocent parties.' Otherwise, the door is open for gross injustice to alert inventors and baffling uncertainty will hinder orderly development of useful arts.

The District Court properly ruled that petitioner had 'acquired intervening rights which in equity plaintiff [respondent here] might not now disturb'.

In *Ashland Fire Brick Co.* v. *General Refractories Co.*, (1928) 27 F. 2d 744, 745-746, the matter of 'Intervening Rights' was lucidly discussed. The opinion states the case thus—

> 'This is the usual suit for infringement, based upon reissue patent No. 15,889, August 12, 1924, to Tackett for a brick machine. The defense chiefly relied upon in the court below and here is that, between the date of the original issue and the application for the broadened reissue, the defendant had built and begun to operate its machines in a form which was not covered by the original patent, even though it were by the reissue, and that the defendant had thus acquired such a right, intervening with reference to the original and reissue, as to make it inequitable to enforce against it the later and broader monopoly.'

And it concluded—

> 'Because the claims of the original patent were limited as to the form of conveyor, and because after the issue of the original patent and with knowledge of it and expressly appreciating its limited character, indeed, being governed therein by the advice of patent counsel, the defendant built a noninfringing brick machine, and still before the reissue application another one, at a substantial expense, and put them into commercial use on a large scale by extensively selling their product, and thus made them substantially material to its manufacturing business, the defendant thereby acquired at least a right to continue to use these two machines as if it held a license therefor under the reissued patent.'

We think this conclusion was right and appropriate in the circumstances presented.

In the instant case the accused machine went into operation when the owner had no actual knowledge of the original patent; but that circumstance we think ought not to defeat the defense based upon intervening rights. All patents must 'be recorded, together with the specifications, in the Patent Office in books to be kept for that purpose.' U.S.C. Title 35, §39. Constructive notice of their existence goes thus to all the world. *Boyden* v. *Burke,* (1852) 14 How. 575, 582; *Wine Ry. Appliance Co. v. Enterprise Ry. Equipment Co.* (1936), 297 U. S. 387, 393; Walker on Patents, Deller's Edition (1937) Vol. 3, p. 2176. In consequence the owner of the machine here accused operated it with implied knowledge of the original patent and may justly claim whatever privileges would follow actual knowledge.

Grant v. *Raymond, supra,* speaks disparagingly of one who having obtained knowledge of an invention from a patent thereafter appropriates what might have been claimed but was not. In the different conditions of today that observation would not be appropriate. We cannot conclude that one so circumstanced occupies a position superior to an honest inventor or user who has acted with implied but no actual knowledge of a recorded patent. 'The purpose of the statute undoubtedly was to provide that kind of relief which courts of equity have always given in cases of clear accident and mistake in the drawing up of written instruments,' and these courts are always tender of rights claimed by innocent parties. 'A sense of justice and of policy' shelters them." (293-295)

Cited in *Keller* v. *Campbell*, 264 U. S. 314

CROWN CORK & SEAL CO. OF BALTIMORE CITY v. ALUMINUM STOPPER CO. OF BALTIMORE CITY *et al.*, 108 Fed. 845 [C. C. A. 4th] [1901]

Interval—7 months

Motive of Reissue—To effectuate protection of real invention.

Subject Matter—The patent dealt with bottle caps. The Court reviewed many of the decisions of the Supreme Court of the United States and passed on both the defense that the reissue was not for the same invention as the original and on the defense of intervening rights.

HELD

[As to same invention and bona fide inadvertence]

"In the present case the reissue is strictly confined to the invention described in the original and included under the statement therein. It does not fall within the class of cases represented by Miller v. Brass Co., 104 U. S. 350, 26 L. Ed. 783, or Coon v. Wilson, 113 U. S. 268, 5 Sup. Ct. 537, 28 L. Ed. 963, where a different invention is described in the claim, but in that other class where reissue is authorized by the plain terms of the statute and by a long line of decisions of the supreme court, where the patent had failed to clearly and adequately secure the invention upon which the original was founded, and where the unquestionable object and effect of the reissue was to cover an invention not covered by the original claims. In this class of cases there should not be applied a stricter rule of diligence than that applied by statute in case of public use before application for the patent, even if so strict a limitation as that is applicable. The suggestion in Miller v. Brass Co., and other like cases, of two years as the ordinary limit of

reasonable diligence, was based not upon any such limitation in the statute, but upon the fact that the two years were allowed for amendments after action of the patent office, and two years was the limit of public use allowed before application for the patent. The learned counsel for defendants assumes that the subject is so simple that Painter should have discovered instantly, upon reading the original patent, the occasion for the reissue, if it existed. He forgets that what seems so simple and easy to him, a past master of the subject, was not so to a mere inventor, unskilled in the art of interpretation, who could not, upon a mere reading of his patent, determine what his claims covered. Painter had no hesitation and no doubt what his invention covered, and almost immediately upon the hearing of the issue of Hall's patent he said that it was covered by his invention; but it was not until he was advised by his lawyer that he learned that his claims were not commensurate with his invention, and there was no delay then in filing his application for reissue. Some allowance may well be made for an unlearned man, when we remember that in the recent case of Westinghouse v. Power-Brake Co., 170 U. S. 537, 18 Sup. Ct. 707, 42 L. Ed. 1136, the supreme court itself required three hearings before it could determine the meaning and scope of the patent claims, and the record in this case shows that such learned experts as General Spear and Mr. Walker differ radically as to what the claims of the original patent cover." (857)

"It will not be profitable to continue the citation of the numerous cases on this subject. Analysis of them will show that there is a distinction well marked between reissues broadening the claims of the original, but confined to the invention therein exhibited, which the courts sustain, and reissues that depart from the invention exhibited in the original and included under its statement of invention.

Where there has been an expansion of the patent to describe inventions substantially different from the original, covering nebulous combinations not exhibited therein, and where there has been protracted and unreasonable delay in face of the manufacture of articles not substantially covered by the original invention, the reissue has been held void; but the courts, recognizing the fact that the ordinary inventor is not usually skilled in technical rules of construction, and is apt to suppose that his claims protect him in the essential elements mentioned in them, and that these claims and specifications are usually drawn by men who are strangers to and ignorant of the art within which they lie, and that even skilled solicitors are not infallible in framing technical documents, have sanctioned reissues which permit the framing of claims adequate to secure the full benefits of the inventions designed to be protected by the patent laws." (858)

"It is also argued that claim No. 5 of the reissued patent is broader than any claim of the original patent. We are of opinion that this claim is germane to the invention exhibited in the original, and is included under the statement of invention of the original. It does not exhibit any change in the nature of the invention described, and it simply gives a more adequate description of such invention, which enlarges the claim, but does not enlarge the invention." (859-860)

HELD

[As to Intervening Rights]

"We are further of opinion that there has been in this case no unreasonable delay and no intervening right which forfeits or waives the right of reissue covered by the statute. The Hall patent was applied for in February, 1894, and the application for it could not have been induced by the limitations in the claims of the Painter patent, and there is no reason to believe that the course of the parties

claiming under it was in any respect different from what it would have been if the original had been precisely in the terms of the reissue. Under all the circumstances of this case, the application for reissue was made within a reasonable time. No notice of any manufacture, use, or sale under the Hall patents was brought to the knowledge of Painter before his application for reissue, and there was no manufacture or sale or publicity such as to import notice to him. The case would be different if Painter had unreasonably delayed to assert his rights to reissue after such notice was brought home to him, and where his silence and inaction had misled other parties to their injury; and the fact that the original patent contained a statement of his invention which covered the subject-matter of the reissued claim, and that a reissue to fully secure the invention disclosed was authorized by law, was sufficient notice that this patent was subject to such right of reissue, which right was liable to be exercised at any time at least within two years. The spirit and terms of the law authorizing reissues would be defeated, and the obvious purpose of its enactment would be ineffectual, if we applied to this case those restrictions which some of the decisions apply to cases where there has been long delay in the application for reissue, and the obvious purpose of such applications has been to appropriate subsequent independent inventions not originally disclosed in the patent.' (860)

"The ninth defense raises the question of equitable estoppel, arising out of the conduct of Painter, who, as alleged, stood by for nearly seven months and saw Keizer and his associates organize a company and expend large sums of money in the development of the Hall patent. We need not repeat what has been already said upon this point in the discussion of the questions raised upon the reissue. Within two weeks after the issue of the Hall patent, Painter sent a message to Keizer that he considered the Hall patent an infringement. A competent expert had testi-

fied that this patent infringed some of the claims of the original Painter patent. Keizer is presumed to have known the law which entitled Painter to a reissue. He was entirely familiar with the Painter inventions. He took his chances in the lottery of infringement, and has lost, and cannot be heard now to complain that he was misled." (868)

"The inventive idea whereby a bottle-sealing device of great economy of material, great facility in operation, and great stability in maintenance was secured by the joint and cooperating action of elements which had never before been combined to accomplish the same purpose or operate in the same way was entirely original with Painter. Nothing in the prior art affects his patent. The defendants enjoyed the unusual opportunity of presenting to the trained experts of the patent office every substantial defense which has been presented here. The original and reissued patents were granted in strict accordance with the law. The claims therein clearly cover the invention disclosed in the defendants' patent, and the infringement is so apparent that the experts called by them have scarcely disputed it. Painter's invention is not one of those great epoch-marking discoveries like that of printing, or the steam engine, or the electric telegraph, which opened to their inventors the portals of the Pantheon of the immortals. For such as these the love of fame and the glory of being benefactors of the human kind served alike as motive and reward, but to the patient laborer in workshop and factory the incentive of fame and glory is absent. For them the stimulus of the rewards offered by our patent laws is needed to encourage by the hope of profit that zealous eagerness to improve processes, to remedy defects in machinery, to invent new methods and appliances for saving labor and cheapening production in the numberless articles that are in daily use. It is this stimulus that has made the American mechanic the most alert, observant, and studious of any in the world, and it is the indefinite multiplication of these

small inventions and improvements that has wrought an industrial revolution and brought his country to the forefront of the world s commerce. It was the consciousness that in the knapsack of every private soldier there might be the baton of a marshal of France that inspired her soldiers to unparalleled achievements. In our unheroic, industrial age the central processes of a nation's life lie in production and distribution. The protection and hope of profit held out by our patent laws inspires that stimulating energy which leads to experiment, invention, and all the resulting benefits; a refusal of that protection in a proper case will deaden and destroy it." (869-870)

Cited in *Keller* v. *Campbell*, 264 U. S. 314

GENERAL ELECTRIC CO. v. RICHMOND STREET & INTERURBAN RY. CO., 178 Fed. 84 [C. C. A. 7th] [1909]

Interval—10 years

Motive of Reissue—To enlarge claim to dominate interim different device.

Subject Matter—The patents dealt with an electrical circuit breaker. The reissue changed the description but not the subject matter and broadened the claim. The decision was controlled by the doctrine, well established by then, that broadened reissues filed after a delay of more than two years are invalid.

HELD

"Inevitably it follows, we conclude, that the application to recast the claims now under consideration was made, not for the purpose of narrowing the original patent because the patentee had claimed too much, but rather for the purpose of holding a wider monopoly than could have been

built up under the invention as described and disclosed in the original patent. Under the teachings of Miller v. Brass Co., 104 U. S. 350, 26 L. Ed. 783, and other authorities cited, such an attempt must be held futile.'" (90)

Cited in *Keller* v. *Campbell*, 264 U. S. 314

A. D. HOWE MACH. CO. v. COFFIELD MOTOR WASHER CO., 197 Fed. 541 [C. C. A. 4th] [1912]

Interval—7½ years

Motive of Reissue—Broadened claims to effectuate protection.

Subject Matter—The patents dealt with water motors for washing machines. The Court preliminarily considered the prior art to ascertain the true stature of the invention. It found the patentee a pioneer in a narrow field. It recognized the defense of intervening rights as a question in equity and it ruled against the defendant on clear equitable considerations.

HELD

[As to same invention]

"Respondent says that whether Coffield invented anything or not is beside the mark. In any event, the reissue patent in suit is void. According to this contention, it is invalid because a second and broader claim was by the reissue added to the single claim of the original." (545)

"[1] A reissue patent is not necessarily void because its claims are broader than those of the original. Crown Cork & Seal Co. v. Aluminum Stopper Co., 108 Fed. 857, 48 C. C. A. 72.

[2] The same case holds that a delay of 6 months and 28 days between the grant of the original and the application for the reissue was not of itself fatal to the latter.

The interval in this case is only 18 days longer. We do not think that the difference is great enough to be in itself, and apart from other circumstances, important. It is true that the reissue may not validly claim an invention not clearly shown in the original patent. Parker & Whipple Co. v. Yale Clock Co., 123 U. S. 87, 8 Sup. Ct. 38, 31 L. Ed. 100; Marvel Buckle Co. v. Alma Mfg. Co. (C. C.) 180 Fed. 1002, affirmed by this court without opinion 196 Fed. 1006, 115 C. C. A.—(May 11, 1912).

Nothing of this kind has been here attempted. The added claim of the reissued patent would have been in place of the original. The description of the invention there given was quite broad enough to have supported it." (545)

HELD

[As to intervening rights]

"Unless intervening rights which we are bound to consider arise between the grant of the original patent and the application for reissue, there is no reason why the latter should not be held good. Respondent contends that there are such rights, and that because of them the patent in suit must fall.

[3] What are the facts? On July 21, 1905, E. J. Ornold wrote to complainant that he had chanced to see one of the latter's circulars describing its power washer. He said that he had had quite an experience with different washers, and that the complainant had a winner. He asked if complainant had any representative in the Wheeling, W. Va. territory. If it had not, he would like to have its best terms, etc. On September 18, 1905, an agreement was entered into between the complainant and Ornold by which

the latter was given the exclusive right for five years to sell the complainant's machine in Ohio county, W. Va. It was agreed that Ornold should work that territory to the best of his ability and means and should forfeit all rights under the agreement if he or his assigns should attempt to sell any competing machines. In the same month of September, 1905, Ralph W. Howe, who, as before stated, was then trading as the A. D. Howe Machinery & Supply Company, saw for the first time one of the complainant's machines. It was on exhibition at the West Virginia State Fair at Wheeling. Howe had then known Ornold for about four years. In October, 1905, the very month after Ornold made his written agreement with complainant and after Howe had first seen the Coffield m tor, they began manufacturing a motor for the same purposes as those for which complainant's were made and sold.

When these facts, or some of them, came to complainant's knowledge, it put an end to Ornold's agency for it. In March, 1906, it brought an infringement suit against respondent in the court below. Some informal negotiations between the parties were then had. The respondent said that it had stopped, or would stop, making the infringing motor. In form this promise appears to have been kept. It told complainant that it intended in the future to make a form of motor, which in this case has been called No. 2. Complainant had no objection to respondent making such devices and selling them if it could. Respondent did make some of them. It never made many. Whether it ever intended to may be doubted. Complainant says that they never could have been a commercial success. If respondent ever purposed to make their manufacture and sale a business, it speedily changed its mind. The evidence shows that when complainant's suit was brought—that is, in March, 1906—respondent was still making and selling its earliest type, that which in the record is called No. 1. Respondent claims that as early as the last week of April,

1906, it put its third type upon the market. This last type is that at which the present suit is directed. Complainant denies that respondent sold any of this form called No. 3 until some months later. The evidence offered by respondent to prove that it did falls short of establishing it. If it were true it would seem that respondent would have been able to show the fact beyond peradventure. On the other hand, it is certain that as early as May, 1906, Howe and Ornold made application for a patent in which they described what is substantially the motor which they were making and selling at the time the present suit was brought. Upon this application a patent No. 841,649, was issued January 15, 1907. In respondent's brief, and in the oral arguments of its counsel at this bar, much was said about this patent. It does not appear to us that it has any material bearing upon the case." (545-547)

"Respondent, however, relies upon this application for a patent and upon the making and selling of the present type of motor both, as it says, before complainant applied for a reissue, as showing that it had acquired intervening rights which could not be taken from it by anything which complainant might afterwards do.

As already stated, the fact that No. 3 motor was in any substantial sense put upon the market before complainant applied for its reissue is not proved. If it were, under the special circumstances of this case it would profit respondent naught. The evidence leaves no room for question that Howe and Ornold, from the time the former first saw complainant's device, set about appropriating it to their own uses. If, as often happens, Coffield has been so unfortunate as not to secure legal protection for his inventive idea, and as a consequence it became a part of the public domain, he and complainant must stand their loss. In that event Howe and Ornold, like everybody else, may freely use what Coffield invented but failed to keep. But nothing which Howe or Ornold *did* in this matter gained for them anything which

could without misuse of language be called *rights*. In the atmosphere of a court of equity it usually takes longer than 7 months and 16 days for intentional wrongs to ripen into intervening rights.

We have already said that in the absence of such rights complainant is entitled to all that the reissue purports to give it." (547).

Cited in *Keller* v. *Campbell*, 264 U. S. 134

AUTOPIANO CO. v. AMERICAN PLAYER ACTION CO.,
222 Fed. 276 [C. C. A. 2d] [1915]

Interval—4 months

Motive of Reissue—To effectuate protection.

Subject Matter—The patents dealt with a control for player pianos. Litigation occurred on the original patent and resulted in a holding of non-infringement. The patent owner was ill advised by a new attorney to secure a reissue in which all of the claims of the original were surrendered and certain narrow claims accepted instead. Appreciating this result, plaintiff immediately consulted his former attorney and was advised to secure a second reissue which was applied for within four months of the granting date of the first reissue and in which the claims of the original patent were restored, the claims of the first reissue patent retained and three additional claims secured. Suit on the second reissue was based on some of the claims which had appeared in the original patent, some of the new claims which first appeared in the second reissue patent, and none of the claims which were contained in the first reissue patent.

HELD

[As to intervening rights]

"Before the second reissue was granted, however, and while the public was advised that the rights which complainant claimed were those only announced to the public in the first reissue, defendant began the manufacture of player piano actions with automatic regulation of the register between note sheet and tracker bar." (282)

"That defendant entered upon the manufacture and sale of these automatic trackers before the grant of the second reissue made public the fact that complainant was making claim to the broad invention covered by the claims here in issue is fully established. That only five of these player piano actions were actually sold is immaterial. Not only the five are free from this reissue, but the business of manufacturing and selling automatic trackers of the type shown in Exhibit N, which was entered into in the belief, warranted by complainant's conduct and mistakes, that defendant's tracker would not be challenged as an infringement under either the original patent, which had been given up, or the reissue, which did not cover it, cannot be interfered with under the second reissue." (282)

"We therefore reach the conclusion that complainant is estopped from claiming infringement by this particular defendant in continuing the manufacture and sale which it entered upon while the first reissue was the only public announcement of complainant's alleged monopoly." (282)

Cited in *Keller* v. *Campbell*, 264 U. S. 134

AMERICAN AUTOMOTONEER CO. v. PORTER,
232 Fed. 456 [C. C. A. 6th] [1916]

Interval—1 year, 2 months

Motive of Reissue—To broaden the claims to remove unnecessary limitations.

Subject Matter—The patents dealt with the mechanical elements and construction of electrical controller regulators. The Court considers in detail various aspects of the reissue law and reviews many of the decisions.

HELD

[As to same invention]

"The reissue was very frankly for the sole purpose of broadening the claims. No consequential error in the specification was suggested, and the only 'inadvertence, accident, or mistake' alleged was the omission to make the additional claims which were said to have been necessary to make the monopoly or protection of the patent as broad as the invention disclosed by the specification and drawings. The mistake or inadvertence was that of the applicant, induced by a negligent or unskillful solicitor." (458)

"The claims of the original patent did not reach and protect the invention thus described. Two or three of the claims included, as elements, directly or by necessary implication, the handle and the controller rod and the jaws for locking the handle to the cover; but in such claims these elements were grouped in combination with a large number of other elements not involved in this thought, and it follows

that these claims were so narrow as not to protect broadly the idea of making the rod and cover coupling in this way." (458)

"Defendant urges that reissue for the purpose of such expansion is invalid—even if there are no 'intervening rights'—and presses upon us the Supreme Court and the Seventh Circuit decisions below cited." (459)

"It is well understood that at the time of the first statute 'specification' was an inclusive term, covering what, in later nomenclature, are identified as 'specification' and 'claims'; and though in 1870 the distinct identity of claims was recognized, it is not to be supposed that the re-enactment of this part of the act of 1836 contemplated any different definition of the terms used than had been understood and accepted with reference to the same terms in the earlier statute. Indeed, the last edition of Walker on Patents (4th Ed. §§ 111, 173) says that the claims are part of the specification. See, also, Macomber, pages 71[1] and 822[2]. Thus giving to the statute its necessary interpretation when applied to the present-day subdivision of the statutory word 'specification', we find it distinctly declared that a reissue may be

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[1] "The term 'specification' has been loosely used. In reading the decisions of earlier times, one finds it embracing description, claims, and even drawings—all that the patentee contributes to the grant—but most commonly to the description and the claims."

[2] "The term 'specification' is used in a twofold and confusing manner. As used in the statutes, it means both the descriptive portion and the claims. As commonly used by the Patent Office and by patent attorneys, it means the descriptive portion alone. The courts use the term in both ways, but the tendency in the more recent decisions is to mark the distinction as the Patent Office has done."

granted when the patent is inoperative by reason of defective or insufficient specification or claims.

The statute does not say 'wholly inoperative'; and although a patent may, in the strict sense, be operative if it grants any monopoly of anything, yet if it fails to secure to the inventor the monopoly of his actual invention, it surely does not operate according to the intent of the law."

"The further and last statutory condition is that the reissue must be for 'the same invention'. It is true that, for purposes of determining infringement, the identity of the patented invention is fixed by the claims; but to apply the same test to identity of invention as between original and reissue loses sight of the difference between the real invention and the originally patented invention, and unless there is such a difference, there is no occasion for reissue. To recognize that difference and permit it to be corrected is the whole purpose of the reissue statute; and so it seems quite destructive of the statute to assume that the identity of the actual invention is permanently declared and fixed by the form which the original claims are inadvertently allowed to take. In the same way as with reference to mistake, the question of identity is submitted to the Patent Office, and for the same reason its conclusion is to be taken as prima facie right. The last sentence of section 53 even permits the Patent Office, in certain cases, to go entirely outside the record to determine what the original invention was. It follows that only when it is clear that the reissue is not for the same invention are the courts justified in reaching that conclusion; and we take this to be the rule of the decisions hereinafter cited.

We thus see that, apparently, the statutory inoperativeness, insufficiency, and inadvertence may exist, even though the only correction to be made is to broaden the claims by omitting unnecessary limitations, and that the particular invention first claimed in the reissue, may be sufficiently

disclosed in the original merely by specification and drawing, and without express verbal reference thereto. To the contrary effect, upon one or more of these points, defendant cites the cases in the margin,[4] and insists that they establish invalidity in a reissue made for the mere purpose of broadening the claims, if in a case where the first description contains no statement of the broader concept. Some of them do contain language to this seeming effect, yet we think in each the result will be found sufficiently controlled by laches, intervening rights, rewritten and altered description or drawing or other clearly distinguishing fact. Further, it is, in some aspects, a question of fact whether the reissue is for the same invention, and these decisions are, in some measure, conclusions of fact applying to the instant case rather than of law making a rule for future cases. However all this may be, if they would otherwise have the effect claimed, they are inconsistent with Topliff v. Topliff, 145 U. S. 156, 171, 12 Sup. Ct. 825, 36 L. Ed. 658, where it is expressly declared that there may be a valid reissue for the purpose only of broadening claims, and where, if the original description indicated any broader view of the invention than the original claim declared—save by describing the actual structure—that fact was not regarded as important enough to mention in the discussion. We are satisfied to hold that the necessary insufficiency of specification may consist only in that the claims are too narrow; that the

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[4] Clements v. Odorless Co., 109 U. S. 641, 648; McMurray v. Mallory, 111 U. S. 97, 103; Turner Co. v. Dover Co., 111 U. S. 319, 326; Mahn v. Harwood, 112 U. S. 354, 357, 360; Coon v. Wilson, 113 U. S. 268, 277; Worden v. Searls, 121 U. S. 14, 24; Parker v. Yale, 123 U. S. 87, 97; Hoskin v. Fisher, 125 U. S. 217, 223; Flower v. Detroit, 127 U. S. 563, 571; Electric Co. v. Boston, 139 U. S. 481, 501; General Co. v. Richmond Co. (C. C. A. 7), 178 Fed. 84; McDowell v. Ideal Co. (C. C. A. 7), 187 Fed. 814; Peoria Co. v. Cleveland Co. (C. C. A. 6), 58 Fed. 227, 239.

necessary inadvertence or mistake may be found solely in the action of the patentee or his solicitor in framing these too narrow claims; that the original and reissue may be for the same invention although the original specification does not expressly indicate that the invention was regarded more broadly than the claims declared it; that upon all these questions, the decision of the Patent Office makes a prima facie case; and that only in a clear case of (actual or presumed) deliberate acceptance of the narrow claims or actual or presumed intervening rights or a clear case of departure from the real original invention as it may be found in the description and drawings will the courts say that the reissue is invalid. See cases cited in margin.[5]

If the original specification and drawing disclose a structure with five elements, and it is apparent that three of them make an operative combination, the other two being useful but unnecessary additions—though the possible use of three only is not mentioned—and if the claim includes all five, and so is limited to the more complex combination, there is in these facts alone no bar to a reissue securing the simpler combination of three elements if the patentee was in truth the first inventor. Upon principle, we cannot escape this conclusion, and we find no controlling decision to the con-

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[5] Battin v. Taggert, 17 How. 74; Seymour v. Osborne, 11 Wall 516, 544, 545; Mahn v. Harwood, 112 U. S. 354; Eames v. Andrews, 122 U. S. 40, 58, 59; Topliff v. Topliff, 145 U. S. 156, 165, 171; Houghton v. Whitin Wks. (C. C. A. 1), 153 Fed. 740; Thompson Co. v. Black River Co. (C. C. A. 2), 135 Fed. 759, 764; Showcase Co. v. Baker (C. C. A. 6), supra.

This view has seemingly long been followed by the Patent Office, pursuant to the fully reasoned conclusions of its controlling tribunal, the Court of Appeals of the District, by Justice Duell, former Commissioner of Patents, in In re Briede, 27 App. D. C. 298. See also, In re Heroult, 29 App. D. C. 42, 53; Nelson v. Felsing, 32 App. D. C. 420, 426; Otis v. Ingoldsby, 35 App. D. C. 102, 106.

trary. Of course, if the original claims did not touch that part of the structure to which the reissue claim pertains, a somewhat different question would arise. If the opinion cited from the Seventh Circuit (General Co. v. Richmond Co. and McDowell v. Ideal Co.) carry implications against this conclusion, they must be read with the decision of the same court in Moneyweight Co. v. Toledo Co., 187 Fed. 326, 109 C. C. A. 586, in which it is held that the original claims do not fix the identity of the actual invention. Since the claim constitutes the only statutory medium for declaring the scope of the invention, as distinguished from its structural embodiment, it seemingly must follow that an omission to specify its true breadth in the place where that is not required—the description—cannot be more fatal than the same omission in the claim, where the formulation is required." (460-462)

HELD

[As to intervening rights]

"Defendant next urges that there were 'intervening rights' which prevented such a reissue, and relies upon Clements v. Odorless Co., supra, and similar cases, as showing that the three patents issued between the date of original issue and the date of application for reissue, sufficiently constitute or evidence those intervening rights which will bar a reissue. The reissue statute fixes no limit of time within which the application must be made, and does not specify that rights, accruing to the public or to individuals, after the first issue and before the application for reissue, shall affect the latter right. Miller v. Brass Co., 104 U. S. at page 350, 26 L. Ed. 783 (see Walker [4th Ed.] § 226), which first declared this additional condition, did not elaborate the foundation reason for so doing, but we think it

must be assumed that the principle of estoppel (perhaps in favor of the public generally) is at the bottom of the rule. By the issue of a patent, the inventor dedicates to the public everything which he does not claim as his monopoly. Upon this dedication, the public has a right to rely, and if members of the public devote time and money to the manufacture of a device which the inventor has so dedicated, or to the devising, inventing and patenting of structures which embody such a feature, it may be presumed that this is done upon the faith of the dedication; and so the inventor may not be permitted thereafter to enlarge his monopoly to the prejudice of these new rights,—even though, except for them, the reissue would be permissible. The settled doctrine has come to be that from a delay of more than two years, and in the absence of any sufficient contrary evidence, these fatal intervening rights (public or private) will be presumed; in the presence of less delay, they must be proved. But see White v. Dunbar, 119 U. S. 47, 52, 7 Sup. Ct. 72, 30 L. Ed. 303; and Milloy Co. v. Thompson Co., (C. C. A. 6), 148 Fed. 843, 847, 78 C. C. A. 533.

Since a patent grants or creates no right to manufacture the thing patented, but only a right of exclusion (Swindell v. Youngstown Co., 230 Fed. 438, C. C. A. (C. C. A. 6—Feb. 8, 1916), it would seem that intervening patents, not followed by manufacture, can furnish the necessary basis for this rule (in a case of less than two years' delay) only because of the effort and expense involved in making and perfecting the inventions to which they relate; in other words, because the absence of the broad claim in the earlier patent has encouraged or misled the later patentee to make and perfect an invention which he would not have undertaken if the earlier monopoly had been wider.

In this case, each of these three patents was applied for before the issue of the Weyand original, and so, at the time of such original issue, was a pending application showing

an invention then completed and reduced to practice. Such patents, which merely go to issue in the interval, cannot raise the estoppel upon which this doctrine must at last depend—though it may be called 'public policy'. There is no evidence that the inventors under any one of them manufactured, and so they do not seem to have done anything in reliance upon the apparent dedication made in the first patent, excepting merely that they paid their final fees." (462-463)

Cited in *Sontag Stores Co.* v. *Nut Co.*, 310 U. S. 281

ASHLEY v. SAMUEL C. TATUM CO.,
240 Fed. 979 [S. D., N. Y.] [1917]

Interval—8 years

Motive of Reissue—To broaden claims to effectuate protection.

Subject Matter—The suit was on a design patent where the original patent had been excessively narrow due to mistaken formalities of the Patent Office Rules.

HELD

[As to same invention]

"This suit is for infringement of a reissue of a design patent for a glass inkstand. The original patent No. 37,504, was granted to the complainant, Frank M. Ashley, August 8, 1905, and the patent was reissued December 23, 1913. Judge Learned Hand held the original patent valid and infringed by this defendant in the case of Ashley v. Tatum (C. C.) 181 Fed. 840. That decree was reversed by the Circuit Court of Appeals (186 Fed. 339, 108 C. C. A. 539), and the patent was held valid, but not infringed. The complainants' inkstand and the alleged infringing inkstand

before the court in this suit are the same, or substantially the same, as those involved in the former suit. After the decision of the Circuit Court of Appeals, the complainant sought for a review by writ of certiorari, but the writ was refused, and thereafter a reissue was granted which is believed to have been the first reissue ever granted in the case of a design patent. The original patent was granted when the rules of the Patent Office did not permit a written description of a design patent, but only a diagram of the design. The original patent stated that the complainant, Frank M. Ashley had—

> 'invented a new, original, and ornamental design for an inkstand, of which the following is a specification, reference being had to accompanying drawing, forming part thereof. The following is a plan view of an inkstand showing my new design. I claim the ornamental design for an inkstand as shown.'

In the reissue patent, the specification sets forth that:

> 'The essential feature of my design consists in the general outline of the stand, which comprises, a low, broad, flat base surmounted by a low dome in which a funnel shape dip cup is located. Having thus described my invention, I claim an ornamental design for an inkstand, consisting of a low, broad, flat base surmounted by a low dome and a funnel shape dip cup located within the dome, substantially as shown and described.'

Judge Lacombe, writing for the Circuit Court of Appeals, in the former case of Ashley v. Tatum, supra, said:

> 'It may be that upon the state of the art at the date of his application complainant would have been entitled to a claim calculated to secure to him the dom-

nant feature of his device, with or without ornamentation, unless, indeed, the ornamentation was carried to such an extent as substantially to modify the effect produced by the contour and proportions. But there is no such claim, and no written description upon which it could be based. The circumstances that both are absent, possibly solely because the Patent Office refused to allow any written description to be filed, does not give this court the power to write such a description and claim into the patent. We must construe the claim according to the rule laid down in the Dobson case as 'covering the design as a whole, and not any part of it as a part; [testing it] as a whole—as to infringement.'

We cannot, therefore, eliminate the element shown in the drawing, viz., the absence of any applied ornamentation. That element must be held to be as essential as any other element. In defendant's inkstand, the general contour of base and dome in the same relative proportions is found; but around the lower half of the dome there is a series of circumferentially displayed facets which effect a substantial modification of appearance of the inkstand by suggesting the idea that it is made out of cut glass, instead of pressed glass. The difference between the two is readily apparent to any one —expert or nonexpert—and there seems no likelihood that, whether looked at together or apart, the one could be mistaken for the other. In our opinion, infringement of the claim has not been made out.'

It seems clear from Judge Lacombe's opinion that the Circuit Court of Appeals has held that the defendant's design was such a departure from the diagrammatic description of the complainant's design contained in the original patent that it did not infringe. Both Judge Lacombe and Judge Learned Hand held that the particular

feature of complainant's invention, which was new and meritorious, was the flat, broad base of the inkstand, surmounted by a low dome, and the pleasing effect based on the simple and useful combinations. Judge Lacombe spoke of these characteristics as the "dominant" features of the design.

It was with a view to obtaining protection for the design of any inkstand having these dominant features, and not being limited simply to the particular inkstand in use, that the complaint sought and obtained a reissue patent. In view of the rules of the Patent Office at the time the original patent was applied for, which seem to have prevented the complainant from broadly describing his invention by means of a written description, and limited him to a diagrammatic drawing. I cannot say that the original patent was not issued under a mistake, due to the belief on the part of the patentee that a diagrammatic drawing gave him all the broad rights of his invention. The question of inadvertence, accident, or mistake, unless manifest from the record, should be left to the decision of the Commissioner of Patents. Topliff v. Topliff, 145 U. S. 156, 12 Sup. Ct. 825, 36 L. Ed. 658." (980-981)

"A reissue of a design patent, the original of which was taken out at a time when the rules of the Patent Office limited the applicant to a diagrammatic description, is not open to suspicion because the claims cover the dominant features and are not limited to a verbal description of nothing more than the exact diagrammatic drawing shown in the specification of the original patent—in other words, because the claims have been broadened." (982)

[As to intervening rights]

"I think it clear that the defendant's inkstand has the dominant features described in complainant's claim in the reissue patent, and that it infringes complainant's reissue

patent, and the complainants should succeed in this suit unless they are barred by laches, or by intervening rights. Defendant's intervening rights arose out of a design patent for a so-called diamond inkstand No. 40,125, granted to S. E. Hilles, July 6, 1909—four years prior to the date of the granting of the reissue patent in suit." (981)

"Ever since the issue of its patent for the diamond inkstand granted July 6, 1909, the defendant has done a business in the manufacture and sale of these inkstands which I have held infringed complainant's reissue patent. This business appears to have been larger in the first two or three years after the issue of the Hilles patent than it has been since. While, therefore, the defendant may not have manufactured or sold large quantities of its inkstands, it is nevertheless an incontrovertible fact that it has manufactured and sold under the Hilles patent a substantial number of inkstands, and that neither the patent nor the inkstand infringed Ashley's original patent according to the construction placed thereon by the Circuit Court of Appeals. I can feel no doubt that a business of some importance has been built up by the defendant between the dates of the granting of the original patent and of the reissue, and that consequently intervening rights have arisen within the legal acceptation of the term. Under these circumstances, complainants cannot be allowed to claim infringement by this particular defendant in continuing the manufacture and sale which it entered upon while the * * * [original patent] was the only public announcement of complainant's alleged monopoly.' See Autopiano Co. v. American Player Action Co., 222 Fed. 282, 138 C. C. A. 38." (982)

"While, therefore, the reissue patent is valid and infringed, this suit cannot be maintained against this particular defendant, because of its intervening rights, and the bill must be dismissed, with costs." (982)

Cited in *Sontag Stores Co. v. Nut Co.*, 310 U. S. 281

ASHLAND FIRE BRICK CO. v. GENERAL REFRACTORIES CO., 27 F. (2d) 744 [C. C. A. 6th] [1928]

Interval—1 year.

Motive of Reissue—To cover interim non-infringing machine.

Subject Matter—The patents dealt with brick machines. The opinion was written by Judge Denison, who also wrote the opinion in American Automotoneer v. Porter, 232 Fed. 456. This is the case referred to by this Court as "lucidly" discussing the matter of intervening rights in Sontag Stores Co. v. Nut Co., 310 U. S. 281.

HELD

[As to intervening rights]

"The defense chiefly relied upon in the court below and here is that, between the date of the original issue and the application for the broadened reissue, the defendant had built and begun to operate its machines in a form which was not covered by the original patent, even though it were by the reissue, and that the defendants had thus acquired such a right, intervening with reference to the original and reissue, as to make it inequitable to enforce against it the later and broader monopoly." (745)

"The doctrine of intervening right, as a defense in an infringement case based upon a reissue patent, has never been elaborated by the Supreme Court; its nature and force must be picked out from the various assumptions of its existence and more or less incidental applications of it which that court has made. After a further study, as thorough and careful as we can make, the court as now consti-

tuted finds itself satisfied to accept and act upon and to adopt the general line of discussion found in the American-Porter Case, and to hold, as we now do, that, because the claims of the original patent were limited as to the form of conveyor, and because after the issue of the original patent and with knowledge of it and expressly appreciating its limited character, indeed, being governed therein by the advice of patent counsel, the defendant built a non-infringing brick machine, and still before the reissue application another one, at a substantial expense, and put them into commercial use on a large scale by extensively selling their product, and thus made them substantially material to its manufacturing business, the defendant thereby acquired at least a right to continue to use these two machines as if it held a license therefor under the reissued patent. The case does not require any further definition of that right.[1] The Supreme Court and the C. C. A. cases which in our judgment tend to support this conclusion are noted in the margin.[2]" (746)

"In approving and adopting the theory of estoppel to support a private intervening right in the nature of a license as against a generally valid reissue, we do not overlook the difficulty which sometimes exists in finding all the

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[1] It is also not without importance, although we do not consider it as here vital, that the plaintiff was moved to the reissue only by learning that the defendant, a competitor, had built these or one of these noninfringing machines.

[2] Mahn v. Harwood, 112 U. S. 354, 361; Coon v. Wilson, 113 U. S. 268; Parker Co. v. Yale Co., 123 U. S. 87; Topliff v. Topliff, 145 U. S. 156, 165, 169; Autopiano Co. v. American Co. (C. C. A. 2), 222 F. 276, 282; Keller v. Adams Co. (C. C. A. 9), 287 F. 838; Supreme Co. v. Security Co. (C. C. A. 9), 299 F. 65.

elements of a conventional estoppel. If, within the two-year period and before the defendant, relying on the limitations in the original patent, has acted to his prejudice (e. g., by building a noninfringing machine) the patentee had filed his application for reissue, manifestly the defendant could not claim any intervening right, although he acted upon the faith of the dedication in the original patent, being without knowledge of the reissue application. This consideration is not, we think, inconsistent with the finding of a true estoppel in a case where the reissue application had not been filed thus early. The right to claim the estoppel depends upon the dedication and its existence as a continuing offer of immunity. By his reissue application, the patentee withdraws that offer, in the only generally possible way. When the defendant acts, he knows that the offer may have been withdrawn in this effective but nonpublic way, and he takes his chances upon the existence of such a withdrawal. Lacking any legislation, the loss must fall upon the later comer." (746)

"While it must be conceded, as the court below held, that the Supreme Court has never expressly upheld the defense of a private intervening right, or distinguished from the general public intervening rights, but has recognized the unsettled character of the questions (Keller v. Adams, 264 U. S. 314, 44 S. Ct. 356, 68 L. Ed. 705), and while perhaps the basis of the two-year rule as to reissues should be called laches rather than estoppel, yet the name is not important, for it is the reliance by the public on the dedication, to the public's (presumptive) injury, which in the typical case develops mere delay into fatal laches." (747)

Cited in *Sontag Stores Co.* v. *Nut Co.*, 310 U. S. 281

MOTO METER GAUGE & EQUIPMENT CORP. v. E. A. LABORATORIES, INC. 55 F. (2d) 936
[E.2D., N. Y.] [1932]

Interval—11 months

Motive of Reissue—To add claims.

Subject Matter—The patents dealt with automobile horns.

HELD

[As to intervening rights]

"There remains for consideration an exceedingly interesting question. It is the matter of intervening rights, as effecting claims 33 and 34, arising out of the manufacture by the defendant of what was called its 'Broadway Horn.'" (939)

"It appears that the defendant began the manufacture of this horn in June or July of 1926 and continued to manufacture the horn for three years. During that time several thousand of the horns were made. The first commercial output was in January, 1927." (940)

"There seems to be no question under the authorities that, if the defendant had originated its production of the Broadway horn some time after the issuance of the original patent and before the filing of the application for the reissue patent, intervening rights would have arisen. Can it be said with force and conviction that, because such origination preceded the issuance of the original patent, the defendant acquired no such rights? The essence of the intervening rights arises out of an estoppel—and because of some act done by the defendant. To create an estoppel it would in principle seem sufficient, if any act of the pat-

entee led the defendant, between the issuance of the patent and the application for the reissue, to a course of conduct inconsistent with the claims of the later patent, even though such conduct was but a continuance of that which the defendant had done prior to the original issue." (940)

Cited in *Sontag Stores Co.* v. *Nut Co.*, 310 U. S. 281 .

CHRISTMAN v. NEW YORK AIR BRAKE CO.,
1 F. Supp. 211 [N. D., N. Y.] [1928]

Interval—1 year, 7 months

Motive of Reissue—To enlarge claims to cover interim different device.

Subject Matter—The patents dealt with piston valves for air pumps.

HELD

[As to intervening rights]

"The patentees, soon after the obtaining of the patent, offered the same for sale, to defendant among others. Correspondence, covering quite some period, passed between the parties, and resulted in the patentees shipping their device to defendant for examination. The device was returned, and the negotiations for purchase and sale were ended. Soon thereafter the patentees made claim that defendant was manufacturing and selling air pumps which infringed upon their patent. This the defendant denied, and the patentees, after investigation, seem to have conceded that the device used by defendant was not an infringement upon their patent. Immediately or soon after the discovery of this fact they made application for a reissue of the patent." (211)

"At about the time Christman and Johnson obtained their patent the defendant commenced applying piston valves to its pumps. There is some discrepancy in the evidence as to whether this device was adopted by the defendant prior to the date of the original patent to Christman and Johnson or subsequent thereto." (212)

"This sale was prior to the grant of the original patent. The construction of these pumps, made prior to the issuance of the original patent is shown to be identical with the pumps charged to infringe the reissue. Between the date of the original patent and the application for the reissue, the defendant made and sold some nineteen hundred of these pumps. Therefore the record clearly establishes that defendant did in fact make and sell, from the date of the issuance of the original patent to the time of application for the reissue, large numbers of pumps of a design not covered by the claims of the original patent but claimed to be covered by the reissue. This action on the part of the defendant seems to place it squarely within the authority of Auto Piano Company v. American Player Action Company (C. C. A.), 222 F. 276. Under the authority of last-cited case, Ashley et al. v. Samuel C. Tatum Co. (D. C.), 240 F. 979, and similar cases, complainant cannot be allowed to claim infringement of defendant in continuing the manufacture and sale which it entered upon long before the reissue." (212)

Cited in *Sontag v. National Nut*, 310 U. S. 281

WOOSTER v. HANDY, 21 Fed. 51 [C. C., S. D., N. Y.] [1884]

Interval—12 and 10 years

Motive of Reissue—To enlarge specification and claims to dominate interim different machines.

Subject Matter—There were two reissue patents in suit dealing with ruffling attachments for sewing machines.

HELD

"The rule laid down by the supreme court is, that where it is sought merely to enlarge a claim, there must be a clear mistake and inadvertence, and a speedy application for its correction, with no unreasonable delay; that, in such a case, a patentee cannot wait until other inventors have produced new forms of improvement, and then apply for such an enlargement of his claim as to make it embrace those new forms; and that when it is apparent, from a comparison of the two patents, that the reissue is made to enlarge the scope of the patent, the court may decide whether the delay was unreasonable, and the reissue, therefore, void. This view has been repeatedly asserted and applied by the supreme court in numerous cases decided since those in 104 U. S.

As to the Pipo reissue, No. 6,565, it is plain that the right to reissue was lost by the delay of more than 12 years, because the case is one of a mere expansion of the claims, beyond anything stated in the original patent as the invention, and with no proof of mistake or inadvertence, and it is sought to make the new claims embrace, in this case, structures brought into use between the time of the issue of the original patent and the time of the application for the reissue, and which were not infringements of the claim of the original patent." (54)

"The original Robjohn patent does not anywhere in the statement of invention, or in any claim, suggest that his invention was anything else but the invention of mechanism for making a band-ruffle by means of two automatic guides, one to fold in the band and the other to guide the strip to be

ruffled; or that he had invented a separator plate, or any means of ruffling a strip above a plain piece." (62)

"These studied efforts to convert the bottom of the guide, E, into something other than the bottom of a guide, and into a supporting or secondary plate, dissevered from a guide, and to introduce the feature of ruffling a strip of goods above a plain piece, in addition to ruffling it in connection with a band which has two parts, an upper part and an under part, and thus to pave the way for introducing claims 8 and 9 of the reissue, are supplemented by the introduction into the reissue of the following new matter:

> 'The ruffled strip may be stitched, as formed, on to a plain fabric introduced under the guide, E, and between the support or plate, *i*, and the feeded, *r*, the latter engaging and moving the plain fabric with the ruffle attached, while the ruffling knife or blade engages only the strip to be gathered, and carries it forward to the needle.'" (63)

"The circumstances under which the plaintiff applied for these reissues, after he thus became the owner of the two patents, and the object he had in view in doing so, are stated by himself. He was using the Pipo and Robjohn machines in the business of making ruffles. His attention was called to the Johnston ruffler and the Toof ruffler, as ruffling devices to be attached to sewing-machines; and he was applied to to sell the Robjohn patent, owned by his wife. He then examined the matter in connection with both patents, and concluded that they could be reissued with the claims now in them, so as to cover such ruffling attachments. He then purchased the Pipo patent, and took an assignment of the Robjohn patent, and applied for the reissues. The Johnson and the Toof rufflers were in the market." (64)

"There is no evidence that there was, in fact, any inadvertence, accident, or mistake." (65)

"In view of the descriptive part of the original specification, claims 8 and 9 of the reissue could not have been sustained on that specification." (66)

IN THE

Supreme Court of the United States

October Term, 1941
No. 680

U. S. INDUSTRIAL CHEMICALS, INC.,
Petitioner,

vs.

CARBIDE AND CARBON CHEMICALS CORPORATION,
Respondent.

PETITION FOR REHEARING.

SAMUEL E. DARBY, JR.,
LEONARD A. WATSON,
Counsel for Respondent.

CLAIR V. JOHNSON,
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PETITION FOR REHEARING

The opinion of the Court states that the "voluntary introduction of water into the reaction chamber" is described as optional by the reissue specification, whereas it had not been so described by the original, and concludes hence that the new claims of the reissue are invalid.

Respondent petitions for a rehearing of the question whether such difference invalidates the new claims of the reissue as not for the "same invention" as the original. The Court's opinion as rendered is inconsistent with elementary principles of chemistry.

Respondent presents the following reasons for the petition:

I.

By statutory requirement a patent disclosure is addressed to those "skilled in the art or science to which it appertains".

The invention at bar is concededly of *pioneer character* in the abstruse field of catalytic chemistry, yet the Court has substituted its own opinion for the opinion of qualified chemists (to whom alone the patents are addressed), both on the question of what the *invention is* which the patents disclose and on the question of parity of alternative procedures as embodiments of *that invention*.

The Court's opinion states:

> "the court may be aided in understanding not what the instruments mean but what they actually say."

Certainly the statutory requirement allowing a reissue patent only for the "same invention" as the original deals with *substance* and not with immaterialities.

> "It is not the *construction of the instrument, but the character of the thing invented*, which is sought in questions of identity and diversity of inventions."
>
> *Bischoff* v. *Wethered*, 76 U. S. 812 (816).

> "In determining about similarities and differences, courts of justice are not governed merely by the names of things; but they look at the machines and their devices in the light of what they do, or what office or function they perform, and how they perform it, and find that a thing is substantially the same as another, if it performs substantially the same function or office in substantially the same way to obtain substantially the same result; and that devices are substantially different when they perform different duties in a substantially different way, or produce substantially a different result."
>
> *Bates* v. *Coe*, 98 U. S. 31, 42.

If, as the present opinion indicates, the Court may *not* be enlightened as to the *substance* of patent-disclosed inventions ("what the instruments mean" *to workers in the art*) then it is of slight interest whether it understands what patents "actually say". On the other hand, if the Court intended to concede admissibility of testimony as to what patents "actually say" *to persons skilled in the art*, then the Court seems to be unaware that it rejected the conclusive testimony of two such persons, wholly disinterested, on that precise question.

Dr. Arthur B. Lamb, Director of Chemical Laboratory of Harvard University, was handed a copy of the original Lefort patent prior to trial and asked to carry out the process as disclosed thereby by him as one skilled in the art, and to report what he *did* in carrying out this assignment. *He did not know that the patent had been reissued* nor that any controversy was pending. He merely practiced what the original patent "actually said" to him. Having done so, Dr. Lamb was called as a witness and testified to what he actually *did* in translating the printed instructions of the patent to an operating embodiment of the invention thereby disclosed (R. I. pp. 237-260).

The Court now holds, in effect, that Dr. Lamb's procedure was *not* set forth in the original patent, although he was guided by nothing else!

Likewise, Dr. J. C. W. Frazer of Johns Hopkins University (selected by the District Court as a disinterested advisory expert in the art), testified that, to practice the invention disclosed to him by the original patent, he would actually have conducted *the same procedure* which Dr. Lamb conducted (R. II. p. 71).

The testimony of these two chemists is thus on the precise question of what the original patent specification "actually says" *to the only persons whose understanding is legally relevant*—namely, to those skilled in the art to which the invention pertains. In the present case their testimony

is controlling on that question. The rejection of this testimony in the opinion rendered amounts to no less than the substitution of the Court's *opinion* in place of skilled chemists' *knowledge* as to what a document dealing with chemistry discloses to a chemist. The errors of scientific fact into which the Court has fallen are the not unnatural consequence of its error in disposing of the case on what the patents say to *it* instead of what they say to *persons skilled in the art.*

II.

Having found the difference between the original and reissue, again the Court substitutes its own judgment for the judgment of skilled workers in the art as to the *significance* of that difference to the chemical *invention* involved. There is no testimony in the record which warrants the conclusion that such difference is other than immaterial from the viewpoint of the *invention* disclosed and intended to be claimed by the original Lefort patent.

The witnesses on both sides testified that, for all purposes of the issues of the case with respect to water, consideration must be limited to the reaction zone (R. II. pp. 96-97). Thus considering the process, there are *in this zone,* by disclosure of the reissue as well as the *original* specification, identically the same ingredients (ethylene, oxygen and water), identically the same conditions (a temperature of 150° to 400° C. and a silver catalyst), identically the same reactions, and identically the same end products. Neither the original nor reissue mentions or is concerned with *proportions* of ethylene, oxygen and water relative to each other; and it is agreed the proportions are immaterial. It is not disputed that Lefort made a *broad invention* of radically new character. Despite this established fact, and with neither the issue nor the evidence on the issue before it, *the Court in effect has held Lefort's*

invention was so extremely narrow that it did not embrace even a functionally immaterial variation of known equivalency. Only on this premise can the conclusion rest that the reissue is not for "the same invention" as the original.

In the case of *Abercrombie & Fitch* v. *Baldwin*, 245 U. S. 198, the Court had before it a question of difference between original and reissue specifications in a simple mechanical device. The original specification described an element as *bent*, and the reissue pointed out that it might be *straight*. There was no question of the *factual* difference, but it was obvious to the Court that such difference was immaterial from the aspect of the *invention*, and the reissue was held directed to the same invention. In the present case the difference as to water is to a skilled worker in the art even more obviously immaterial from the aspect of Lefort's originally patented *invention*.

III.

The error which underlies the Court's opinion may be demonstrated by comparing two assumed procedures as follows.

In one, atmospheric air containing 2% of water is first dried, and then rehumidified by adding the same 2% of water, and then passed with ethylene through a reaction zone in the presence of silver and at a temperature of 250° C. to yield ethylene oxide in given amount.

In the other, the same atmospheric air, already containing the desired 2% of water, is passed with ethylene through the same reaction zone under the same conditions to yield the same quantity of the same desired product.

In both cases, the same ingredients enter the reaction zone, the same controlled reactions occur, and the same products leave it. The only difference is that in the second case one has omitted the useless and mutually nullifying

operations of taking water out of the air with one hand and "voluntarily introducing" it to the air with the other.[1] The second is not a different *invention* from the first.

IV.

The found difference between the *specifications* of the original and reissue patents as to the introduction of water does *not* exist between the claims of the original and reissue. It is the latter—the claims—which constitute definitions of the *invention* in the scope as intended to be patented, i. e., *the patented invention.*

The specification must describe an operative embodiment, which embodiment may include any number of unessential details, but such details (when unexpressed in the claim and alike unnecessary to operativeness and patentability) do not inhere in nor measure the *invention patented.*

The original Lefort patent *claims* (see Claim 1 for example) define the invention without any expressed limitation whatever as to the *source* of either oxygen or water. Since, however, the claim itself called for subjecting ethylene "to the simultaneous *action*" of both, both must be *present.* The *presence* (and hence "action") of water is likewise expressly required by reissue claims 8 and 9 as was explicitly conceded by petitioner's counsel at the hearing. Accordingly the found difference between the two *specifications* as to "introduction" of water does not exist in the claims which identify the *invention patented.*

The opinion correctly states the well-known rule,

> "And it is not enough that an invention might have been claimed in the original patent because it was suggested or indicated in the specification. It must appear

[1] It is also worth noting that the defendant operates by leaving the water already in the atmospheric air and *adding more.*

from the face of the instrument that what is covered by the reissue was intended to have been covered and secured by the original."

The opinion then finds that similar facts meet that rule as to one element but not as to another.

Claim 1 of the original patent reads fairly and squarely on the practice of the defendant except for the limitation as to the catalyst. Had this unnecessary and mistaken limitation not occurred in the claim, a reissue of the patent for new claims would not have been sought. Yet the defendant admitted, and the Court correctly accepts, the proposition that claiming *silver* by the reissue is still claiming what "was intended to be covered and secured by the original".

Yet, on the item of water, the new reissue claims do not have even so much difference from original Claim 1, which calls for "subjecting" ethylene "to the simultaneous *action* of oxygen and water". Whatever the "action" of the water *is*, that *action* inevitably occurs if water is *present*.[2]

Consequently, when the opinion states that the important thing is to determine not what the patent *means*, but what it actually *says*, and then holds that in the original patent the "voluntary *introduction*" of water is "described *and claimed* as an integral part of the whole operation", the opinion has become self-contradictory. Claim 1 of the original patent *says* absolutely nothing as to the *introduction* of water. So far as concerns what this claim *says*, it is absolutely immaterial whether the water be *introducted* voluntarily or involuntarily or whether it be *formed in situ* from other *introduced* substances well known to pro-

---

[2] It may be that the Court was under the misapprehension that "action" means "reaction". Of course that is not true. The *action* of the water is not one of chemical change. It is one of influencing by its presence, in a manner not even yet wholly fathomed.

duce water. The claim calls for the *action* of water, and not for the *step of introducing it.* The same is true as to oxygen. Naturally either molecular oxygen, or something which yields molecular oxygen, must be *introduced* to the reaction chamber. Naturally, likewise, either water, or some ingredient which yields water, must be *introduced* to the reaction chamber.[3] The *invention* which Lefort *made*, and the invention which he *sought to patent*, was in subjecting ethylene to the simultaneous "action" of oxygen, water, a catalyst, and a certain elevated temperature. The unambiguous language of original Claim 1 has thus paradoxically been held to *mean* something other than it *says*, in the same opinion which states that only what it says is important.

V.

The Court has erred in many of the factual statements in the opinion made in support of its ultimate conclusion. We think specific discussion at this time is unnecessary. Nevertheless we assert their existence lest the Court assume that any argument above advanced is weakened or rendered unsound by other matters of the opinion not specifically herein treated. Lest this statement itself be dismissed on account of its generality we add a short appendix of specific examples for reference in case the Court considers them important at the present stage.

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[3] Plaintiff's position has been consistent throughout, namely that the introduction of water is no more optional in the reissue than in the original, and no more mandatory in the original than in the reissue, *with respect to the invention made by Lefort, intended to be claimed by the original, and actually claimed by the reissue.* And, furthermore, the difference, assuming one, is *immaterial* to such *invention.*

VI.

In no earlier reported case of this Court has a reissue patent been held invalid as for a different invention from the original when the alleged difference was *immaterial* either from the viewpoints of means, of mode of operation, of novelty, or of patentability. Likewise in no earlier reported case has such conclusion been reached at the behest of a defendant which was *not practicing* the "difference" it was proclaiming.

Rehearing is requested in order to harmonize the decision with the Record and with elementary chemical principles.

Respectfully,

SAMUEL E. DARBY, JR.
LEONARD A. WATSON
Counsel for Respondent.

CLAIR V. JOHNSON
CLAIR W. FAIRBANK
Of Counsel.

Appendix

1. The opinion states:

> "In contrast, the reissue treats this step as immaterial and mentions the introduction of water as for the mere purpose of controlling the temperature in the reaction zone,—although not even suggested by the specification of the original patent which, on the contrary, in its very first sentence, speaks of the simulfaneous action of the oxygen of air and of water."

Any chemist knows that the process in the reaction zone is exothermic, hence that temperature control is a matter of keeping the temperature *down* to 150° to 400° C., and that, when the original patent speaks of water "checking the formation of carbon dioxide", this "action" of water tends to keep the temperature *down* because the formation of carbon dioxide releases ten times as much heat as does the formation of ethylene oxide.

2. The opinion states:

> "The court below was persuaded by expert testimony that, from a chemist's point of view, the prescribed step (the introduction of water) was immaterial; in other words, chemists testified that, by carrying out the procedure, omitting the introduction of water, they obtained the result described in the patent."

The Court is in error. No witness testified that he omitted the introduction of water, or obtained ethylene oxide without introducing water, in carrying out the procedure of either the original or reissue patent. They varied the *amount* introduced, but *not* the *introduction*. The *amount* has been admitted to be *immaterial* (R. II. p. 92).

3. The opinion states:

> "We think the court below fell into error in adopting the scientific conclusion of expert witnesses that the

result would be the same whether water were introduced into the reaction chamber or not as proof that Lefort's invention was not what he stated it to be in his original patent but rather the invention of a process of bringing ethylene and oxygen into contact in the presence of a catalyst."

The testimony of the expert witnesses was not offered or used below as proof that Lefort's invention was "a process of bringing ethylene and oxygen into contact in the presence of a catalyst" nor has plaintiff ever so urged or the court below so held. Lefort's invention secured by the reissue patent and disclosed as intended to be secured by the original was the process of contacting ethylene and oxygen *and water* in the presence of a catalyst at a *specified temperature.*

4. The opinion states:

"Nor does it [the argument of sufficient water being present from the side reaction] suggest how the reaction can be initiated or caused when dry oxygen is used and the side reaction has not commenced."

Any chemist knows that some ethylene and oxygen would react under the conditions to produce carbon dioxide and water. Being informed that, in the presence of water and the other conditions, ethylene oxide would also be formed, they hence knew that the process would be initiated by the *introduction* of *water* or of such *water-producing* elements. In practice, the "reaction zone" is a long tube of small diameter. Water *formed* therein at any point is cumulatively *introduced* to succeeding points.

5. The opinion states:

"Experiments conducted by the respondent just before it acquired the patent demonstrated that ethylene oxide could be produced by passing ethylene and air over a catalyst at the temperature described in the patent without the voluntary introduction of water."

Both the statement and the implication are in error. In the experiments conducted by respondent, ethylene and oxygen *and water* were *introduced* over the catalyst at the prescribed temperature to produce ethylene oxide. The reissue application was not motivated by reason of any experimental investigation whatever with respect to water nor drawn on any other basis than the exclusive disclosure of the original specification to workers skilled in the art. (R. I. pp. 267, 268, 275, 276)

6. The opinion states:

> "The District Court made no finding directed to this fact, [whether the original specification treated introduction of water as optional] but the court below definitely holds, and we agree, that, in the process defined in the original patent, the voluntary introduction of water into the reaction chamber is mandatory."

The District Court not only made the Finding (8) that Dr. Lamb *followed the original patent* in his procedure, but that what he did

> "conclusively demonstrates that there is no variance between the subject matter of the original and reissued patent".

Moreover, the court below expressly affirmed these Findings.

7. The opinion states:

> "He [Lefort] found that, by certain control of the process, this side reaction could be so restricted as not to decrease the production of ethylene oxide below a profitable level."

This statement that Lefort's restriction of the side reaction had any detectable relation to the "profitable level" of ethylene oxide production by direct oxidation of ethylene

is an assumption without any record support and is factually not true. What made the process commercially profitable was cheapness of its raw materials, its directness, and its specificity to ethylene oxide *as distinguished from aldehydes.*

8. The opinion states:

> "The claims of the original patent are not limited to the oxygen of air; and the specification merely says the oxygen 'can be the oxygen of air.' The specification and claims of the reissue are satisfied by the introduction of dry oxygen."

The "introduction of dry oxygen" satisfies the specifications and claims of *both* the original and reissue, *but only if the other conditions including the presence of water are also met.* The *presence* of water is satisfied in the claims of both patents, as a matter of elementary chemistry and a matter of sound law, by its *introduction* into the reaction zone either as water or as a well-known water-former.

We particularize these errors so frankly because it is apparent that the Court has been misled into accepting defendant's fallacious arguments by our own fault in not earlier pointing out why those same arguments, when urged on both courts below, were rejected.

We hereby certify that the foregoing petition is presented in good faith and not for delay.

SAMUEL E. DARBY, JR.
LEONARD A. WATSON
Counsel for Respondent.

pp 2, 6.

SUPREME COURT OF THE UNITED STATES.

No. 680.—October Term, 1941.

U. S. Industrial Chemicals, Inc., Petitioner, *vs.* Carbide and Carbon Chemicals Corporation. } On Writ of Certiorari to the United States Circuit Court of Appeals for the Fourth Circuit.

[March 30, 1942.]

Mr. Justice Roberts delivered the opinion of the Court.

This is a suit by the respondent to restrain the petitioner from infringing claims 8 and 9 of reissue patent No. 20,370. The application for reissue was filed September 25, 1936, and granted May 18, 1937. The original patent was No. 1,998,878, applied for March 22, 1932, and granted April 23, 1935, to Theodore Emile Lefort, of Paris, France, for a "Process for the Production of Ethylene Oxide". The application was based on earlier French patents. The respondent purchased the United States patent in April 1936 and, as a result of its study thereof, the patentee was persuaded to apply for the reissue.

If the reissue patent is valid, no question is now raised as to petitioner's infringement of the claims in suit. The District Court held the patent valid and infringed.[1] The Circuit Court of Appeals affirmed.[2] We took the case because of an apparent conflict with decisions of this court and several Circuit Courts of Appeals, to the effect that a reissue patent must, under the statute, be for the same invention as the original patent.[3] The petitioner

[1] 34 F. Supp. 813.

[2] 121 F. 2d 665.

[3] R. S. 4916, 35 U. S. C. § 64: "Whenever any patent is wholly or partially inoperative or invalid, by reason of a defective or insufficient specification, or by reason of the patentee claiming as his own invention or discovery more than he had a right to claim as new, if the error has arisen by inadvertence, accident, or mistake, and without any fraudulent or deceptive intention, the Commissioner shall . . . cause a patent for the *same invention*, and in accordance with the corrected specification, to be reissued." . . . (Italics supplied.)

also raised a question as to intervening rights which, in the view we take, need not be considered or decided.

Ethylene is a hydrocarbon gas, C_2H_4. For a long time it was thought impossible directly to oxygenize it to form C_2H_4O by bringing oxygen and ethylene into contact, though the formation of ethylene oxide by direct oxidation was commercially desirable. Efforts at direct oxidation, instead of producing the oxide, resulted in less desirable oxygenated compounds such as aldehydes. Lefort conceived the idea of effecting the oxidation by catalytic reaction, that is, the use of a substance, which, in some unexplained way, causes a chemical union or reaction when the two substances to be affected are brought into contact in its presence under given conditions. He recognized one incident of the direct oxidation process as applied to ethylene tending to decrease its efficiency, namely, that, in addition to the principal reaction producing C_2H_4O, there occurs a side reaction by which a portion of the ethylene is converted into carbon dioxide and water, and, to that extent, the ethylene is wasted. He found that, by certain control of the process, this side reaction could be so restricted as not to decrease the production of ethylene oxide below a profitable level.

According to both the original patent and the reissue, ethylene and oxygen are to be introduced into a heated reaction chamber in the presence of a catalyzer. The petitioner insists that the original patent also treats as a mandatory or necessary step the voluntary introduction of water, whereas the reissue in specification and claims 8 and 9 omits this requirement, and therefore describes a different process. The respondent, on the other hand, asserts that as both patents describe the oxygen of air as that which may be used, and as atmospheric air contains moisture, the first, specifying water, and the reissue specifying air, both contemplate the introduction of water in some form and therefore are for the same process.[4] This dispute must be resolved by a comparison of the disclosures of the two instruments.

[4] No question of unreasonable delay is presented. Compare Mahan v. Harwood, 112 U. S. 354, 363; Ives v. Sargent, 119 U. S. 652, 661; Topliff v. Topliff, 145 U. S. 156, 169. Nor have we occasion to decide what may be the scope of permissible court review of the commissioner's determination that the error of the patentee arose "by inadvertence, accident or mistake, without fraudulent or deceptive intention."

If that comparison leads to the conclusion that the reissue is not for the same invention as the original, the reissue is void as not within the terms of the statute.

We shall postpone discussion of the tests of identity or difference of invention, and the use of expert testimony, to a statement of the criteria of judgment furnished by the language of the specifications and claims of the two documents.

The opening paragraph of the original patent is:

"This invention has for object a process for the production of ethylene oxide which mainly consists in subjecting ethylene to the simultaneous action of the oxygen of air and of water in presence of a catalyzer and, if need be, of hydrogen."

After referring to the use of hydrogen as optional, the specification deals with the character and composition of metals to be used as catalyzers. It then speaks of the elements to be used to obtain the desired reaction thus:

"The ethylene can be obtained from any source of supply:

"Water can be admitted to the reaction vessel, either in the liquid state, or as steam.

"The oxygen can be the oxygen of the air, this latter gas being introduced in the reaction."

Immediately following, it is said:

"The efficiency of the reaction is increased by diminishing the CO_2 which is formed, by introduction, in this reaction, of a suitable quantity of water. A suitable quantity of CO_2 can also be previously introduced in the reacting gases."

The CO_2 which it is desired to diminish is that which is formed by the undesirable side reaction above mentioned. This reaction is again mentioned, and the introduction of water again specified thus:

"Moreover, the applicant has found that the reaction giving CO_2 is, contrarily to previous belief, a reaction of oxidation independent from that giving ethylene oxide and from that giving aldehydes. From experiments effected by the applicant, it results that, if water is introduced in suitable quantity, the reaction is not only facilitated, as above stated, but, in addition, the reaction giving CO_2, probably by direct oxidation of ethylene according to the equation

$$C_2H_4 + 3O_2 = 2H_2O + 2CO_2$$

is checked, owing, as is probable, to the partial pressure of water."

It is further said that the experiments indicate that the side reaction producing CO_2 and water may be completely checked and the efficiency of the reaction producing ethylene oxide increased if CO_2 is previously introduced in addition to the water and the reacting gases.

Three *modi operandi* are next indicated as examples. In the first, compressed ethylene and compressed air are led, with or without hydrogen, into a heated tube containing the catalyzer, the tube being connected with a circulating pump to supply water under pressure. In the second, the catalyzer is introduced and the tube heated and then "a mixture of ethylene, air, water vapour and hydrogen" is sent through the tube. In the third, the catalyzer is introduced into a high-pressure tube filled with water. Pure ethylene is added "in order that it can dissolve in the water." The tube is heated and "air and hydrogen are slowly introduced."

The specification concludes:

"The experiments . . . have shown that, in presence of the catalyzers indicated, water, in the form of steam or not, considerably promotes the reaction ensuring the production of ethylene oxide."

All of the seven claims include oxygen and water or steam. Claim 1 is typical. It runs:

"A process for the production of ethylene oxide, consisting in subjecting ethylene to the simultaneous action of oxygen and water, in presence of a catalyst [describing the catalyst] at a temperature between 150 and 400° C."

In some of the claims the word "steam" is substituted for "water"; in two, "hydrogen" is added.

Various options or alternatives are mentioned in the specifications, but nowhere in them, or in the claims, is the introduction of water treated as optional or permissive. The District Court made no finding directed to this fact, but the court below definitely holds, and we agree, that, in the process defined in the original patent, the voluntary introduction of water into the reaction chamber is mandatory.

Experiments conducted by the respondent just before it acquired the patent demonstrated that ethylene oxide could be produced by passing ethylene and air over a catalyst at the temperature described in the patent without the voluntary introduction of water. Its patent attorney was asked to study the patent and he concluded

that Lefort should have obtained far broader claims. He prepared two oaths for execution by Lefort to support the application for reissue.

In the first it was averred that the specification and claims failed to emphasize the fact that the reaction takes place "whether or not water is present"; and that the attorney in drawing the application had not been adequately instructed that the "fullest benefit and application" of the invention was the production of the oxide in the presence of the catalyst "with or without the inclusion of water in the reaction".

After rejection, the second affidavit was filed. This stated that a certain amount of water was necessarily present in the reaction chamber due to the side reaction which gives CO_2 and water, and that the introduction of additional water and carbon dioxide was merely permissive in order to augment the quantities already formed by that reaction.

Thereupon reissue was granted with a rewritten specification, the seven original claims and two new ones, 8 and 9, which are those in suit.

The substituted specification opens thus:

"This invention provides a specific and novel process for making ethylene oxide. It essentially consists in causing ethylene to combine directly with molecular oxygen at temperatures of about 150° to about 400° C. in the presence of a surface catalyst which favors the oxidation of ethylene to ethylene oxide under these conditions."

The statement is made that ethylene from any source can be used, and that the oxygen can be that of the air.

The only reference to the introduction of water is:

"The oxidation of ethylene takes place with a giving off of heat, and it is, of course, desirable to maintain the temperature of the zone of reaction within the range specified. This can be facilitated by suitable dilution of the reaction gases, such as that accomplished by the use of air as the source of oxygen, and some water or carbon dioxide in addition to that formed can be admitted to the mixture in the reaction zone if desired. Hydrogen may be similarly added."

The description of the mode of conducting the process differs from all those given in the original specification in omitting the introduction of water.

The specification concludes:

"In any case, the ethylene and oxygen are thus reacted simultaneously at the temperatures set forth in the presence of a surface catalyst and of water" . . .

The new claims 8 and 9 are broader than those of the original patent.[5] It will suffice to quote 8. It is:

"The process of making ethylene oxide by the direct chemical combination of oxygen with ethylene in the proportions of one atom of oxygen to one molecule of ethylene, which comprises forming a mixture containing ethylene and molecular oxygen and conducting said mixture through a confined reaction zone which is maintained at an elevated temperature; controlling said temperature to maintain said mixture in said zone at a temperature between about 150° and about 400° C; subjecting said mixture in said zone at said elevated controlled temperature to intimate contact with an active surface catalyst" [describing it, *inter alia*, as one which favors the formation of "oxidation products containing ethylene oxide in the presence of water."] and describing other steps not necessary to be recited.

The question is whether, in the light of the disclosures contained in the two patents, they are for the same invention. This court has said that they are if the reissue fully describes and claims the very invention intended to be secured by the original patent;[6] if the reissue describes and claims only those things which were embraced in the invention intended to have been secured by the original patent;[7] if the broader claims in the reissue are not merely suggested or indicated in the original specification but constitute parts or portions of the invention which were intended or sought to be covered or secured by the original patent.[8] The required intention does not appear if the additional matter covered by the claims of the reissue is not disclosed in the original patent.[9] If there be failure of disclosure in the original patent of matter claimed in the reissue, it will not aid the patentee that the new matter covered by the reissue was within his knowl-

[5] This fact, standing alone, does not vitiate the reissue. Topliff v. Topliff, 145 U. S. 156.

[6] Powder Co. v. Powder Works, 98 U. S. 126, 138.

[7] Parker & Whipple Co. v. Yale Clock Co., 123 U. S. 87, 99; Hoskin v. Fisher, 125 U. S. 217, 223; Flower v. Detroit, 127 U. S. 563, 571.

[8] Corbin Cabinet Lock Co. v. Eagle Lock Co., 150 U. S. 38, 42.

[9] Clements v. Odorless Excavating Apparatus Co., 109 U. S. 641, 647; Coon v. Wilson, 113 U. S. 268, 277; Electric Gas Lighting Co. v. Boston Electric Co., 139 U. S. 481, 501; Freeman v. Osmus, 145 U. S. 226, 239; Olin v. Timken, 155 U. S. 141, 147.

edge when he applied for his original patent.[10] And it is not enough that an invention might have been claimed in the original patent because it was suggested or indicated in the specification. It must appear from the face of the instrument that what is covered by the reissue was intended to have been covered and secured by the original.[11]

As the Circuit Court of Appeals held, the original specification and claims treated the voluntary introduction of water into the reaction chamber as a necessary step in the process whereas such introduction is made permissive by the reissue. We agree with that court's view that there is thus a difference between the procedure described in the two documents. But we cannot agree with its conclusion that the difference is so insubstantial as not to invalidate the new claims 8 and 9. On the face of the papers the process described in the original patent included a step not designated as optional or desirable but described and claimed as an integral part of the whole operation. In contrast, the reissue treats this step as immaterial and mentions the introduction of water as for the mere purpose of controlling the temperature in the reaction zone,—a thought not even suggested by the specification of the original patent which, on the contrary, in its very first sentence, speaks of the simultaneous action of the oxygen of air and of water.

We think it plain that the reissue omitted a step in the process which was described and claimed as essential in the original patent. The court below was persuaded by expert testimony that, from a chemist's point of view, the prescribed step (the introduction of water) was immaterial; in other words, chemists testified that, by carrying out the procedure, omitting the introduction of water, they obtained the results described in the patent. Naturally enough this fact led them to state, as chemists, that the introduction of the water was immaterial. Apparently this testimony induced both of the courts below to conclude that Lefort, when he applied for his original patent, knew that the introduction of water was unnecessary. The inquiry at once arises, if this were so, why did he not say so. If he had discovered a process, which the claims of

[10] Powder Co. *v.* Powder Works, *supra*, p. 138; Manufacturing Co. *v.* Ladd, 102 U. S. 408, 413; Huber *v.* Nelson Mfg. Co., 148 U. S. 270.

[11] Parker & Whipple Co. *v.* Yale Clock Co., *supra*; Flower *v.* Detroit, *supra*.

the reissue are certainly broad enough to cover,—that of mixing dry oxygen and ethylene in the presence of a catalyst at the prescribed temperature to produce ethylene oxide,—it is not understood why, throughout his specifications and claims, he spoke of exposing ethylene to the simultaneous action of oxygen and water or steam.

We think the court below fell into error in adopting the scientific conclusion of expert witnesses that the result would be the same whether water were introduced into the reaction chamber or not as proof that Lefort's invention was not what he stated it to be in his original patent but rather the invention of a process of bringing ethylene and oxygen into contact in the presence of a catalyst.

Although it is the duty of a court to determine for itself, by examination of the original and the reissue, whether they are for the same invention, it is permissible, and often necessary, to receive expert evidence to ascertain the meaning of a technical or scientific term or term of art so that the court may be aided in understanding not what the instruments mean but what they actually say.[12] It is inadmissible to enlarge the scope of the original patent by recourse to expert testimony to the effect that a process described and claimed in the reissue, different from that described and claimed in the original patent, is, because equally efficacious, in substance that claimed originally.[13] If such testimony could tip the scales on the issue of the validity of a reissue, it would always be possible to substitute any new combination of steps or elements or devices for the one originally described and claimed by proving that the omission of any one or more steps would not alter the result.

This court has uniformly held that the omission from a reissue patent of one of the steps or elements prescribed in the original, thus broadening the claims to cover a new and different combination, renders the reissue void, even though the result attained is the same as that brought about by following the process claimed in the original patent.

In *Russell* v. *Dodge*, 93 U. S. 460, the original patent was for treating skins by the use of a compound in which heated fat liquor was expressly stated as an essential ingredient. There was no dis-

[12] Seymour *v.* Osborne, 11 Wall. 516, 546.
[13] Collar Co. *v.* Van Dusen, 23 Wall. 530, 557.

closure that the fat liquor could be used cold. In a reissue the specification was altered by eliminating the requirement that the liquor be heated. The court said:

"The change made in the old specification, by eliminating the necessity of using the fat liquor in a heated condition, and making in the new specification its use in that condition a mere matter of convenience, and the insertion of an independent claim for the use of fat liquor in the treatment of leather generally, operated to enlarge the character and scope of the invention. The evident object of the patentee in seeking a reissue was not to correct any defects in specification or claim, but to change both, and thus obtain, in fact, a patent for a different invention. This result the law, as we have seen, does not permit."

In *Gill* v. *Wells*, 22 Wall. 1, the original patent disclosed and claimed a machine for making hat bodies. One of the elements of the machine was a tunnel through which a current of air was to be passed. The specifications did not indicate that this part could be omitted. The reissue for a machine without any tunnel, was held invalid. The court said (p. 26):

"Argument to show that an invention consisting of a combination of three ingredients which are old is not the same as that of a combination of four old ingredients is quite unnecessary, as the negative of the proposition is as well settled in the patent law as it is in mathematics."

Many other cases might be cited to the same effect.

The court below was persuaded to construe the reissue patent as not differing from the original by the argument that, in both, the introduction of water was not essential to the technological success of the process. When certiorari was applied for in this court, the respondent in its brief said: "The introduction of water, as distinguished from its presence, in the reaction zone is not 'an essential feature' in the invention at bar, and was not 'described and claimed in the original patent as an essential feature.'"

This argument goes upon the theory that if the presence of water is necessary to the reaction, its presence is assured by the side reaction we have mentioned which produces CO_2 and water. It does not explain, however, why, if this is the source of the necessary water, Lefort did not say so in his original patent. Nor does it suggest how the reaction can be initiated or caused when dry oxygen is used and the side reaction has not commenced.

In the argument on the merits in this court, the respondent shifted its position. In brief and argument it stated that both the original and reissue cover the same invention for if both require the introduction of water, the described introduction of air effects also the introduction of water since atmospheric air contains both oxygen and moisture. It is thus sought to avoid the finding of the Circuit Court of Appeals that the original patent called for the voluntary introduction of water and the reissue does not. This argument fails to square with the specification or claims of either the original patent or the reissue. The claims of the original patent are not limited to the oxygen of air; and the specification merely says the oxygen "can be the oxygen of air." The specification and claims of the reissue are satisfied by the introduction of dry oxygen.

In short, to avoid the difficulties which stare one in the face when the attempt is made to read specifications and claims as calling for the same process, the respondent is driven to take inconsistent positions neither of which comports with the plain language of the two patents.

We hold that the reissue is not for the same invention described and claimed and intended to be secured by the original patent and is, therefore, void.

The decree is reversed.

A true copy.

Test:

Clerk, Supreme Court, U. S.